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THE NEW VOTIVE CHURCH AT ST. PETERSBURG.

IMMEDIATELY after the murder of the Emperor Alexander II. of Russia, and before the body was interred, the citizens of St. Petersburg declared their intention of erecting a votive chapel on the spot where the emperor was murdered. Emperor Alexander III. was asked to give his permission, which he did, at the same time expressing the wish that a church be built instead of a chapel. Money was raised in all parts of the empire; presents, such as bells, pictures of saints, etc., were sent from all over the country, and competition designs were called for; but none of these beautiful designs entered were accepted, and before the second competition could be called for the design of Mr. Parlandt and Archimandrite Ignatji, the prior of the Sergius monastery near St. Petersburg, was accepted.

The annexed cut, taken from the *Illustrirte Zeitung*, represents this grand and beautiful building, which is to be erected in the pure Russian style of the sixteenth century. The church will be erected on the spot where the emperor fell, which was on the Katharine Canal, the quay of which extends along the beautiful park of the Michael Palace. A part of this park, which is the property of the Grand Duchess Katharine Michailowna, has been presented to the trustees of the church; the Katharine Canal will be bridged at this place; several other buildings will be removed and the ground leveled; thus making a large square upon which the building will be erected. It is to be about 280 ft. square, and to have six gilded cupolas, of which only four can be seen in the annexed engraving.

The main entrance will be on the west side and in the lower part of a large bell tower or campanile, connected with the church by a small gallery crossing the bridged canal. This tower is 357 ft. high, or 40 ft. higher than the highest dome of the Isaac's Cathedral.

Within the church an open chapel, or, more properly, a canopy supported by four porphyry columns, will be erected over the spot on which the emperor fell, the bloody paving stones being kept under this canopy and raised about three steps above the floor. On the outside this chapel will be distinguished from the rest of the building by a special tower and cupola between the bell tower and the main building. One of the windows will have an elegant stained glass design representing Christ with a crown of thorns.

Among the characteristic features of this church are the galleries or arcade-shaped buildings on the north and south sides, of which only those on the north side are visible in the annexed cut. The ends of the galleries will be closed by small octagonal towers, and in the galleries the innumerable pictures of the saints are to be placed that have been sent from different parts of the empire. The walls of the towers at the ends of the galleries will be ornamented with fresco paintings representing different episodes in the life of the emperor. The material to be used is gray Finland marble and enameled colored bricks. On the facade of the bell tower the coats of arms of all the departments of the empire will be produced in colored tiles, so that the entire front will be rather brilliant and mixed in color, which, however, is quite common in the mediæval Russian style. The influence of the orientals upon the Russian style is clearly shown by this great desire for many and mixed colors. The building is to cost about $10,000,000, and is to be completed in 1891.

THE NEW VOTIVE CHURCH AT ST. PETERSBURG.

THE INFLUENCE OF WOOD UPON ARCHITECTURE.

WE in our studies of architecture freely credit the ancients with the invention or creation of various styles or orders of architecture, and at the same time tamely submit to the taunt that with all our civilization we are unable to create a style or order of our own. That the ancients did invent styles or orders of architecture is a general belief; but if these styles or orders are tested in the light of the influence of wood upon architecture, the credit of such inventions is considerably reduced, and it becomes a question whether any race of people can be looked upon as the inventors of any particular style or order, or whether the cradle of architecture can be found in any country, however ancient.

In dealing with the subject of the heading of this chapter, we cannot confine ourselves to the limits of this country, although mediæval architecture was materially influenced by wood, as in the high pitched wooden roofs of towers, which developed into the graceful spires of stone; we must take a wider field, and carry our mind back to an earlier date.

The architecture of the last three centuries has been drawn from the Romanesque and the Gothic, with occasional indulgence in the Classic orders, the principle of copying being largely followed. In the middle ages the influence of wood was fairly fixed; but in some degree it was debased, the debasement taking the form of constructing the shafts of columns without the Classic taper derived from the trunks of trees, the diminishing lines inseparable from the older shafts of wood being altogether lost.

With the earlier Roman architecture the influence of wood was greater and more pure in its character; but from being drawn from Greek sources, we can follow it like a root in its downward course. The invention of the arch, which was clearly the work of the Romans, and suggestive of building in a more permanent material than wood, had a marked influence on this and later architecture. The arching and vaulting indulged in necessitated an increase in the size and proportions of the earlier columns, until, as in our Norman examples, they lost all the proportions of columns supporting beams as entablatures, and we find them swelled out to nearly the proportions of the openings.

The Five Orders of architecture as practiced by the Romans were modifications of the older Greek orders—the Corinthian, Ionic, and Doric. With these the line of the tapering shafts was in some instances bulged; in others pedestals were introduced consisting of base, dado, and cornice, upon which to place the columns, and the fluting of the older shafts, which was no doubt suggested by the rough incised bark of endogenous trees, was lost or abandoned. In other cases the influence of wood was intensified. Take the Grecian Doric metule, a supporting feature in the lower part of the cornice, which with the Romans became a cubical projection in the form of a solid bracket, suggesting the projecting end of horizontal timbers, the origin of which could only be found in flat roofed buildings.

In the Three Orders of architecture as practiced by the Greeks, the influence of timber is very marked. The shafts are all tapered to the proportions of trunks of trees, and they are all fluted on the face, which may be taken as a severe but conventional form of representing the rough or incised bark of forest trees. In the later or Corinthian style the head of the column is a mass of leaves or foliage, suggestive of a living tree.

As we descend to the Ionic, the head or cap is found to be less ornate, the flat volutes being somewhat at variance with vegetable forms; but when we find them in the later Corinthian they are admittedly traceable to the curled stalks of the acanthus.

The Doric capital is a primitive type, the later base is absent, and the fluting of the shafts is shallow and ridged, the later fillet being absent, and no attempt being made to enrich the upper part with arched lines, necking moulds, or incisions, the shaft being as plain and simple as a pillar of wood. The capital is not endowed with any ornament suggestive of vegetable life; it is merely an agent for changing the round of the

shaft into the square, and thus increasing the bed of the entablature, which was originally composed of beams of wood joined over every pillar or column. The ovolo mould, the only feature of architecture in this cap, is straight on the face and rounded on the outer edge; its object is to assist in changing the round into the square, a later development of which is seen in the Byzantian and Norman cushioned capitals. This capital we cannot trace to wood; but being placed at the top of a wooden column as a bed for a wooden beam, there can be no doubt of its origin being a square slab or wood, shaped on the lower side to assimilate with the round of the column.

The Grecian Doric, as an order, is the parent of architecture; but that it was merely the working in stone of familar types in wood there can be no question.

The origin of architecture is found in the column and entablature, which is here traced to the most primitive forms. The origin of the column is to be found in the shelter or shade from the burning sun necessary to a fixed population, the column being a pillar supporting the roof or shade on the outer or inner face of a clay or mud wall. With an older or nomadic people the column would become the post supporting the awning over the entrance to the tent.

An architecture wrought in stone, even of such a severe and primitive type as that of the Grecian Doric, suggests a settled population, and an amount of civilization that afforded protection to property; it would be the outcome of the wealth of a state or community more than of an individual, and it would be a costly embodiment of a cheaper and more ordinary style of building in more primitive materials. Like the cathedrals, castles, etc., erected in the middle ages, in the midst of clusters of wooden houses, wattled with clay, they would be monuments of the faith and military skill of the people, and would reflect their very highest attainments in the practice of building. That we are not riding a hobby in thus tracing the source of architecture to erections of wood, and its outlines and proportions to the influence of timber, we have proof in Holy Writ, especially so in the building of Solomon's Temple on the great platform of Jerusalem; and it will, perhaps, not be going too far to credit the Jews, not only with furnishing us with our faith, but with our architecture.

Solomon, in building his temple, merely carried on the work commenced by his father, King David, of poetic fame: and in the description that has come down to us in Holy Writ, we can form some idea of the architecture.

It was built in courts, the walls being of stone, the upper stories being thinner than the lower stories. The walls were wainscoted with wood, no stone being seen; the beams lay on the ledges formed by the thinning of the walls. The roofs were flat, of thick planks of cedar, or large cedar beams covered with gold (gilded); the floors were covered with fir. The wainscoting was carved with knops and open flowers, with cherubim and palm trees, within and without. The doorposts were of olive wood; the inner court a row of cedar beams. Carved doors with leaves are mentioned; and posts of olive trees, pillars of almug trees, for the temple and the king's palace. This palace, built for his queen, the daughter of Pharaoh, King of Egypt, was, from the amount of wood used in its construction, called the "House of the Forest of Lebanon." It is described as being built upon four rows of cedar pillars, forty-five in all, with cedar beams upon the pillars. In other cases the pillars appear to have been of stone, and the beams over them of wood: "And he built the inner court with three rows of hewed stones, and a row of cedar beams" (1 Kings vi. 36). The great court is mentioned as being built in the same manner (1 Kings vii. 12). These buildings being so crowded with wood, it is somewhat remarkable that they did not fall an early prey to fire. This was the ultimate cause of their destruction from the torches of the soldiers of Nebuchadnezzar, who destroyed Jerusalem 385 years after Solomon's death. These pillars or logs of wood, the parents of the shafts in architecture, appear to have been the rough form in which the wood or timber was conveyed from the forests. They were, no doubt, fairly uniform in size, the diameter at the butt regulating the length, as suggested by the Grecian Doric shafts being from four to six and a half times the length of the diameter, and the Roman Doric being seven times the length of the diameter at the base. The logs, strange as it may appear, were carried from the forests to their destination. For this purpose Solomon sent a host of bearers to the forests of Lebanon: "And Solomon told out three score and ten thousand to bear burdens, and four score thousand to hew in the mountains" (2 Chron. ii. 2). On the bronze gates of Ballawat one sees the Assyrian soldiers of Shalmaneser II. carrying down beams of cedar wood from Lebanon. We know that this king became possessed of Lebanon, from which he drew large supplies of cedar wood for the city of Babylon. From inscriptions which have reached us, we know that Nebuchadnezzar, the great King of Babylon, employed considerable quantities of wood for his sumptuous building of temples and palaces. In one of these inscriptions, preserved in the British Museum, he even says expressly that "he has employed for the woodwork of the Chamber of Oracles, at Babylon, the largest of the trees which he has had conveyed from the Mount Lebanon." This, as we know, necessitated the carrying of wood across the Syrian desert.

It is a fact, too patent to be gainsaid, that the evidence of documents, rock inscriptions, and ancient architecture proves that wood was paramount in ancient times, and that its likeness or influence is reflected in the architecture of all ages. It is wood that suggested the lines, both perpendicular and horizontal, of Classic architecture, modifications of which have formed the architectural groundword of all the civilized nations of the earth. Along the banks and the delta of the Nile, the architecture has been drawn from tree and plant forms, the tropical character of the district inclining them to imitate palms or endogenous trees, and hence the peculiar fluting and the bulbous outlines of a great part of their columns. The low lying character of the land suggested the water lily or lotus as the groundwork of their ornament, and hence the capitals of their columns partake of their outlines. Like the Greeks, they drew from local sources, and transformed to stone their impressions drawn from constructions of timber, giving them the semblance of life as their art advanced, by ornamenting them with vegetable forms.

It is an old and true saying that there is nothing new under the sun. The ancient Greeks, who built and adorned their immortal temples, were not the inventors of the architectural styles in which they wrought; their outlines were drawn from old and primitive forms of building, in clay and wood, and their ornaments from animal and vegetable forms, their divinest being modeled from the human frame. They were mere imitators—improvers, if you will—but certainly not inventors, and, on the whole, they were little, if any, removed from the architects, ornamentists, and sculptors of the present day, except that they worked in a fixed groove. The Romans invented little beyond the arch; their Tuscan and Composite orders being mere adaptations of the older Greek orders, and even in repeating the Greek orders themselves they merely varied them in detail. They lengthened the columns and diminished the taper, until the whole of Europe and the North of Africa adopted the parallel column, the arch taking the place of the entablature. With the revival of the Classic orders, at the period of what we are pleased to call the Renaissance, the influence of wood in a wrought form became very marked. The pedestals of the columns were paneled as if of wooden framing, and the dadoes, solid features in the walls, took the same form. The tapering column was reintroduced, and wood, as an architectural feature, reasserted itself at this period in a manner that would have surprised the Roman builders.—*W. S., in the Building News.*

THE SHORING OF BUILDINGS.*

I HAVE undertaken to address you upon the shoring of buildings—a most important and interesting subject. Shoring is generally required for the prevention of accidents that might otherwise arise from bad materials or workmanship, from structural damage, or from the removal of adjoining buildings or ground. It is also required as a means of temporary support during alterations. When the defects have been remedied, or the alterations have been made, the work of the carpenter disappears, and may seem to be lost; but this does not make the matter of less importance to ourselves to-night. First, let us mention some of the chief causes of mischief to buildings. Up to the last generation houses were very commonly built without any artificial foundation; before that time they were often built even without footings. Many of our ancient buildings were simply founded on the surface of the ground. I have seen whole streets of modern houses begun by laying the lowest course of bricks dry, upon the grass or on something worse. Foundations that may be just sufficient for a building may be rendered quite insufficient when heavy buildings are erected close to them, compressing the ground. But careful builders have always felt that some artificial foundation was necessary when building on made ground or on bog or silt. Before the general use of concrete, walls were commonly built on planking. The tower piers of some of our great 14th century churches were built on a kind of raft made of trunks of trees. When this wood rots the walls or piers sink, and must be underpinned, requiring shoring, needling, and very careful treatment in small sections of work. Next comes defective walling. Not very long ago it was usual to put, in every story of a wall, two or three courses of bond timber measuring not less than 4 in. by 3 in. I have taken bond timbers 18 in. by 6 in. out of basement walls in the best old houses in Cheapside. When bond timber shrinks or decays, the walls bend inward or settle irregularly. Most of our old London houses were built with little or no tie between the bricks in the face and in the back of the wall—a practice that is still very difficult to check. Such walling buckles and bulges out with a wavy surface, the mortar falling out of beds and joints. I illustrate the practice by a sketch of the upper part of a four-story house in which the outer skin of half a brick in thickness bulged out and had to be taken down, leaving only an inner skin half a brick thick. Not one header had been used in the height of about one and a half stories. To the best of my belief, it was rebuilt on the same principle. Such walls often have, from this cause, a hollow space varying from 4 in. to 7 in., or even more, throughout their whole extent. The most serious operations of shoring are required in the cases of large mediæval buildings. The piers and walls of our 12th century churches were built of rubble or loose fragments of stone, cased in with a mere skin or shell of masonry. In all the old streets in which the dwelling-houses have been turned into shops, the front walls and internal partitions on the ground floor have been freely removed, and the chimney-breasts cut away from the lower part of the party-walls, often without such precautions as would render these operations safe.

Next to a knowledge of the ways in which structures become insecure is the question of the methods of making them temporarily safe. Shoring of some kind must generally be employed, and it is important to employ the right kind in the right way. In the great majority of cases it is not necessary to carry any material portion of the weight of any wall or building. Still less is it required to lift it or to force any inclined wall back into the upright. These last are operations of a very special and exceptional kind. We generally want to stop the present mischief by providing some firm and sufficient resistance to any continued tendency toward falling over. The following headings will cover all these cases:

1. The flying shore, which carries no weight, but is generally a trussed beam, placed horizontally between two buildings in order to prevent one or both of them leaning over the vacant space between them.

2. The raking shore. An inclined prop also used to keep a wall from falling outward, but which will carry some dead weight if applied very carefully for that purpose.

3. The strut, or dead shore, used only for carrying weight, and generally placed under breast-summers or floors.

4. The needle, a short beam supported at the ends by struts, and used to carry a short length of walling.

5. Framed systems of shoring and centering used under arches to carry the dead weight of heavy structures during the rebuilding of piers.

6. Shoring used in combination with some mechanical power for forcing walls back into an upright position.

* By Thomas Hinshill, F.R.I.B.A. A lecture delivered at Carpenter's Hall on Wednesday, March 3, 1885.—*Building News.*

In using any of these contrivances we cannot be too much impressed with the necessity for proceeding gently, so as to avoid all jarring or shock to the building. Shoring is not an affair of sledge-hammers, but should be quietly put in its place, and made tight up to its work with wedges, so as not to injure the structure. It should also be fixed so that it can at any time be erased, and finally removed without any violent shock; and, lastly, it should be so arranged that it will be well out of the way of any work that has to be done while it is in its place. I invite your attention to the models exhibited (see illustrations), which have been made for me with much goodwill by Messrs. Greenwood, the experienced contractors for shoring to the Metropolitan Board of Works.

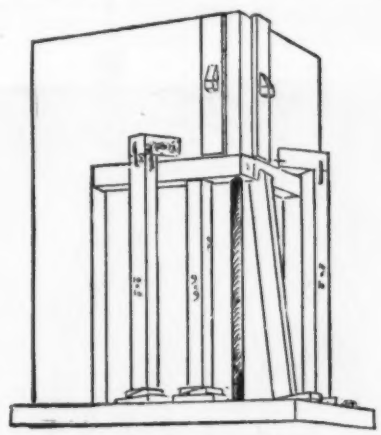
A flying shore is the best contrivance for preserving the position of a wall that is simply in danger of falling over. The assistance that such a wall requires is usually extremely slight. A horizontal beam is fixed across a street or across vacant ground, each end being carried on a short piece of wood that goes through a plank which is fixed upright against the wall. The beam is braced against these two pieces, and has straining pieces secured to it, to form abutments for the braces, which are stopped on the wall-pieces by cleats. The beam is tightened up at one end by wedges. We shall see how all these parts are used in relation to the raking shore. Flying shores can be made of ordinary timber up to a span of between 30 ft. and 35 ft.; for longer spans timber of extra length must be used, or the beam must be scarfed. In such cases, great care is necessary to stiffen the beam and to wedge it tight; but flying-shores can be supported and stiffened by connecting them to others above or below them, or at a few feet distance, or by taking upright posts up from the ground. When the shore has to be removed, the wedges can be loosened, and the upper braces taken away for a few days, if it is desirable to test whether the building has been made secure by the works that have been done to it for that purpose. A flying-shore placed across a street is usually put to support one house against an opposite house that is supposed to be firm. But when deep excavations are being made in the street, the houses on both sides may be supposed to require support from each other; and this is the case when one house in a row has been taken down, and the houses left on each side of the gap require mutual support. It is often supposed that the flying-shore should be made stronger—perhaps twice as strong—when both houses incline to fall as when only one of them is inclining; but if each house is exerting a thrust equal to one ton against the shore, the one will simply counteract the other, and the strain upon the beam will be the same as if one house only was pressing with the force of a ton against another house that was standing firm.

In considering the raking shore, let us note the relation between the beam and the truss. If we have a beam that is fully loaded in the center, we may draw two lines from the point where it is loaded to the two points of support, and if we remove the two gusset-shaped pieces, outside these lines, the beam will still carry its load. If we remove the remaining substance of the beam, except these two lines and the bottom line, and make the three lines strong enough, we have two rafters in compression and a tie in tension, and these will carry the load. If we provide two good abutments and remove the tie, the rafters alone will carry the load. We will now go a further and final step and remove one of the rafters—that which remains is a raking shore. In order that it should support even the smallest load, it is necessary that, in addition to the abutment at the base, it should have some sufficient resistance at the top to supply the place of the opposite rafter. If there is no such resistance, the load will bring the shore down, describing a curve struck from the foot of the shore. There must first be something to shore from; and, secondly, something to shore to. What such a shore will carry when properly arranged may be accurately calculated according to its degree of inclination. It will carry most weight when it slopes least. As a matter of practice, the raking shore is not generally used to carry heavy weights, but to afford such moderate support to a wall or building as may resist its tendency to incline out of the upright. Heavy weights are carried by dead shores and needles. The first thing is to get a solid foundation to start from. If the ground is soft or loose, it may be rammed; if very bad, a floor of planks or stout timbers may be laid down. If vaults or areas exist close to the outer face of the wall, you plant your shore beyond them, or go down to the bottom of them, or use any solid wall you may find between them. When a wide excavation for a sewer is being made in a street, the houses may be shored from whole timbers laid across the street, as well as by flying shores from house to house. It is generally sufficient to take up a part of the paving and lay the sole-piece on the ground below it with the necessary inclination toward the building. It used to be the practice to merely plant as many single shores or props as seemed necessary in the ground, to insert the upper ends for a few inches in the parts of the wall that seemed to need them, and to wedge them tight into these holes. The present practice is to observe the part of a wall that needs a shore (or if the whole wall be inclining, to fix on several places a few feet apart), and there to put up shores. You must have, however, something to shore to. Such defective walls as we constantly see are not fit to have a prop put to them in any careless way. For if the wall is settling, and continues to do so—ever so little—after a raking-shore is put, the shore, having no firm resistance at the top to supply the place of the opposite rafter previously spoken of, will be brought down by the weight, and will push in the wall. The more the shore slopes out of upright, the greater is the danger of this accident. I have seen it happen to one of the unbonded 9 in. walls that I have described, which fell inward upon a chamber floor, and the shore after it. When a flying-shore is made to incline so that its foot comes down on a lower building, the danger of injury to the lower building is very considerable. The safest place for fixing a raking-shore in front of a building is against the end of a party-wall, where most old buildings are insufficiently bonded. There the party-wall gives the necessary resistance, and the same may be said of other cross and return walls. If the part to be supported is between such return walls, the points of supports must be fixed near to the under side of the floors, which will offer sufficient resistance. The mode now adopted for applying the shore to the wall is to provide

a long plank called a wall-piece fixed upright against that part of the wall which needs support. Pieces of wood, called pins or joggles, are passed through the plank and made to project 4 in. into the wall, a half brick being removed at each place where the head of a shore is to come in order to admit the joggle. The wall-piece must be carefully fitted to the face of a wall th[illegible]hogs strings or other horizontal projections by packing out otherwise. It is usually necessary to put more than one shore from the same sole-piece, so that as many as three or four may be made to support the joggles at different heights of the wall-piece. The outer ones may be fixed as "riders" carried on short pieces of timber. Thus, instead of propping a wall at irregular points by several shores having independent foundations, and acting independently against the wall, we have one strongly-framed compound shore, which may be repeated at intervals, in the length of the wall, as may be required. As to the manner of fixing: The shore, having been cut to fit in its place, is set on the sole-piece, and the top, which has been cut with a couple of horns to clip the head of the joggle, is brought up to it. It is dangerous to drive up the foot of the shore with a big hammer, as that would certainly give severe shocks to the building, and probably make the shore too tight. It requires to be just brought well up to its place, and no more. With this object a crowbar is put into a notch cut in the heel of the shore, and it is thus gently levered up until it is felt to be tight. It can then be secured by iron dogs, so that, should the shore become slack, or be subjected to any shock, it may remain fixed at both top and bottom. In fixing a rider, the short piece of timber to form the foot is first set on the sole-piece so as to lie against the back of the shore; the rider is next made to rest on a pair of oak wedges, and is gently brought up so as to clip the joggle by driving the wedges. The feet of the shores are fastened together by hoop iron, which is wrapped round them and well nailed; if necessary, the foot of the outer shore might be cut with a very short tenon, and dropped into a mortise in the sole-piece. It is the common practice to connect the rider and the shore by nailing stout boards in one or more places across each side of them, which are continued to the wall-piece, the whole system thus becoming a strong piece of framing in a triangular form. Solid timber might be used instead of the boards; but these are easily fixed, and are sufficient for ordinary cases. The cleat that is put above the joggle should be very securely fixed, and may be let into the wall-piece if much strain is expected. It is usually nailed, and, practically, has very little to do. As to the dimensions of timber used in shoring, there is a common practice of using deals, which, from their thinness, bend sidewise as soon as any weight comes upon them. When half-timbers are used, there is loss of strength from the same cause. Die-square stuff from 5 in. by 5 in. to 9 in. by 9 in. is the best material for shoring, particularly as there is much chance of accident from a side blow or from the pressure of wind. Fir is the best timber to use on account of its straightness of grain, cheapness, and lightness when being moved. The action of raking shores is a question which those acquainted with mathematics may study with advantage. In the *Building News* for 1877 (Sept. 14 and 21) there are two articles on the subject, and the whole question of shoring and underpinning has recently been dealt with in a book published by Batsford, High Holborn, price 4s. 6d. It was written by the late Cecil Haden Stock, an earnest student in architecture, who managed to do this very useful piece of work at an unusually early age.

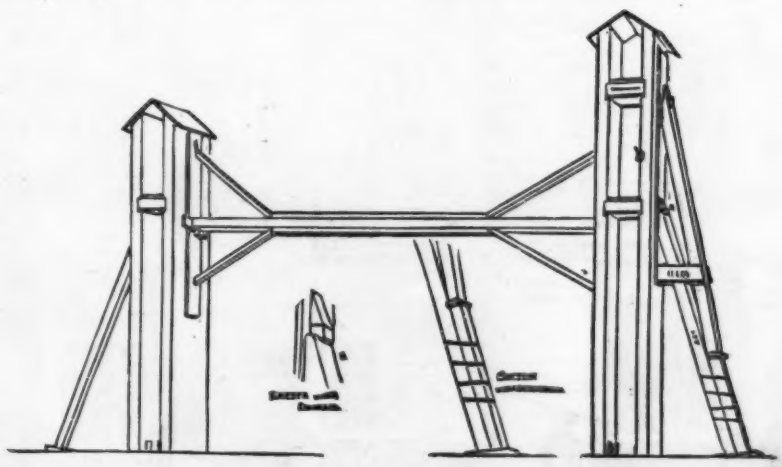
The various ways in which the dead shore or strut is useful need not be catalogued. As a temporary support for girders during the rebuilding of a wall, or during the replacing of a column, it is in common use. I have seen such struts fixed by simply driving them into their place with a sledge-hammer, which very seriously shakes a building. They should be wedged up at the bottom, driving the wedges very gently, and stopping as soon as the strut is made tight. The timber should be solid and sound. One sometimes sees three or four deals lashed together, and made to do duty as a strut. It should be better known that the strength of a column or strut depends very materially on its thickness or diameter, and that three deals, however firmly you may fix them together, are very far short of the stiffness of a post of solid timber of the same dimensions. The utmost care must be taken to see that the strut is set on a solid foundation. A soft subsoil, old vaults or cesspools, must be searched for, and a good sill of timber used to start from.

We now come back to the beam, pure and simple. The "needle" is a short beam loaded at the center, and usually carried at each end by a strut. It should be of good, sound, and solid timber, and if it is ever necessary to use a combination of deals, they should not be laid flat upon each other (as is often done), but placed edgewise, bearing in mind that a 9 in. by 3 in. deal so placed is three times as strong as the same deal laid on its side. Wrought-iron rolled joists are now very often used as needles, for they only require a hole of 4 in. in width, instead of 10 in. or a foot. The model shows the common operation of putting in or replacing a bressummer. You first strut up the floors, not trusting to the bottom floor without examination. Put some timber in the window openings, and support any balconies or projecting parts. Raking-shores are then put to steady the upper part of the house, and the needles are passed through holes under the solid parts of the walling. If any of the struts cannot be fixed sufficiently near to the front, the needles must be made longer and stiffened by strong raking-pieces from the foot of the struts. The breast-summer is then passed into its place, bedded, and the brickwork over it made good in cement. It is often necessary to make a large opening in a front or cross wall, high up or in a position where struts cannot be easily fixed. Then a number of square frames may be made, best of iron, consisting at top and bottom of short needles joined by uprights at the ends. These are put through the walls in the place of ordinary



COMPOUND RAKING SHORE.

needles, the bottom pieces resting on the brickwork, the tops pinned up tight to the wall above. The brickwork along the wall is then cut away of depth sufficient to admit the girder, and after it is made right the frames may be removed and the wall below may be cut away to form the opening. In the same way an arch may be turned over an intended opening by making the temporary frames of height sufficient to suit the rise of the arch. In order to place or to change the column at the angle of a building, a needle is put through the corner diagonally with other needles and raking-shores, of which two should stand close to the corner. When a raking-strut is put under a breast-summer, catching it with a bird's-mouth, remember that there is the same danger and need of good resistance at the top as in the case of a raking-shore, and that the more nearly upright the strut is, the safer and stronger it will be. Whether the formation of an extra basement beneath a building shall be a dangerous or a safe operation depends chiefly on the way in which the shoring is arranged and maintained during the work of underpinning. The most obvious course is to secure the walls of all adjoining buildings by flying-shores and by raking-shores planted on the old level of the ground, *deferring the excavation until the underpinning is completed*. This is executed in lengths of about 4 ft. by sinking shafts at intervals along the face of each wall and needling all parts that require it. The mass of earth that has afterward to be excavated is thus made to support the shoring and the timbering of the shafts until the adjoining buildings are made secure. One of my illustrations shows a curious specimen of shoring of which a record happens to have been kept. A party-wall, the lower part of which was split and ruinous, had to be underpinned, and raking-shores were applied to it. These stood upon soft made ground with a trench close behind them, another trench being made between the shores and the wall for the purpose of underpinning. In that condition of insecurity the wall was left with the rotten work cut out and several courses of underpinning left still undone from Saturday to Monday. You may be surprised to hear that no accident happened, for, if it proves anything, it proves that such work will stand. I am sometimes met by a man whom I have warned for doing something of this kind with the triumphant announcement that nothing has happened. One can only reply that it ought to have happened. There are many things done in dealing with old buildings which may or may not be dangerous—one can only judge by the result. The thing is an experiment. It is risky. It is never worth while, for the sake of a saving in trouble, or even in cost, to run risks that are plainly to be seen. All prudent constructors go a great deal further than that. From a sense of risks that are not obvious, or that may only arise at a distant time, we usually make all kinds of beams strong enough to carry three or four times the greatest weight they are expected to bear. Columns are made of ten times the strength that might seem to be necessary. Provision is thus made for contingencies, and yet accidents sometimes happen in spite of this caution.



FLYING SHORE.

The heaviest works of shoring that we have to deal with are connected with failures in the walls and piers of our old churches and cathedrals. I have found the towers of ordinary village churches, with walls 5 ft. thick, threaten to fall to pieces, because the inside or core of the walls was made up of dry, loose materials that would run out of the cracks like sand out of a bag. Raking-shores and good wall-pieces have to be put against them simply to keep the outer casing of stone steady while the cracks can be cut out and some solid stonework introduced bit by bit. In the case of large central towers, the openings between the four great piers are filled with strong framed shores, and strong raking-shores are put at the angles, until the piers and arches are rebuilt. The shoring of the tower of Grosmont Church, Monmouthshire, carried out under Mr. J. P. Seddon, is a very good example. This tower weighed, above the arches, about 800 tons, but the weight of a cathedral tower will be ten times as much as this. Thirty-five years ago I saw with interest the enormous timbers that carried the tower of Hereford Cathedral while its piers were rebuilt. In such works a deep and solid bed of concrete is first put under and around the tower, the defective parts have to be surrounded with a jacketing of timber to keep the outer casing of stonework together, and prevent the bursting out of the crushed rubblework in the core. Strong frames of the largest timbers are built up, carrying the centers of the great arches. All the walls and arches near the tower are shored up, and a great part of the shoring must be made to remove, bit by bit, as the stonework is renewed. The largest amount of shoring ever used has always seemed to be insufficient. I exhibit a photograph of the shoring put by Sir Gilbert Scott under one of the tower arches of St. Alban's Abbey, not to carry it, but only to form some moderate amount of support.

The operation of restoring a wall to the upright is not often undertaken. We have here a drawing of that used 155 years since in forcing back the transept wall of Beverley Minster some 4 ft. A very interesting operation of the same kind was carried out at St. Alban's Abbey a few years since, where strong frames of timber were fixed in the nave to receive the wall as it was forced into its place by machinery placed outside the building. Let me add a few observations on shoring done in other materials than wood. If you walk round Westminster Abbey or look at the newly-exposed side of Westminster Hall, you will see in the great flying buttresses specimens of shoring in stone, such as was done hundreds of years ago, on the grandest scale and in infinite variety. Between the western towers of Lincoln Cathedral there is a flying-shore in stone of 28 ft. span, and only 11 in. deep. It forms a flat arch, the rise of which is barely 15 in. The tower of Salisbury Cathedral has on every side of it double raking-shores built up behind the older architecture of the lower parts of the church. At Salisbury and Wells cathedrals, and at some other churches, very curious arches, acting as flying-shores, were added to prevent the piers of the tower arches from yielding under their load. In the deep cuttings of the Metropolitan Railway lines flying-shores of cast iron have been very extensively used. All these are well worth our study, even if we only have to prop the front of a common house, and such study ought to sweeten our work. I own that I should feel more hesitation than I do in addressing you on this subject if I thought that every error and omission I may make would lead to permanent mischief. But I comfort myself with the belief that every one who may be noting what I say will take all opportunities of studying the subject in actual execution, and thus correcting his wrong impressions by an appeal to that great foundation of valuable knowledge—the experience of practical work.—*Building News.*

VENTILATION WITHOUT A DRAUGHT.

This long sought for desideratum claims to have been at last accomplished by an Englishman. The plan he adopts certainly has the merit of simplicity, and it seems to be contrived on a correct principle for accomplishing the result.

The air supply is conducted into the apartment from the external atmosphere by means of air ducts, which terminate in distributing passages at the floor level. The exit for the vitiated air is placed in the ceiling, and consists of two tubes, a large and a small one, running parallel to each other between the floor joists in the case of rooms having others over them. In the case of rooms on top floors, or those having the roof directly over the ceiling, the tubes are placed concentrically, but the action and results are the same. The larger of the two tubes carries off the vitiated air, while the smaller one forms an induction tube for cold air, its outer extremity being open to the atmosphere. These two tubes or conduits are so connected that the passage of the heated air through the larger tube induces a current of cold air through the smaller one in a continuous stream. The result is a rapid clearing away of all deleterious gases and products of combustion as they accumulate, and the preservation of a pure atmosphere at an equable temperature in the apartment. The vitiated air is drawn off through the exit tube, which acts as a powerful sucker. The system has already been applied to a church and other buildings with acknowledged success, and we hope to hear before long that its use has been further extended, and that it has proved to be the long looked for remedy for ill ventilated rooms.

WITH a stenographer and type writer the business man can accomplish tenfold the work he could a few years ago. It is not at all an uncommon thing nowadays for an active business man to take a private secretary with a writing machine about the country with him, reducing thereby his own labor and increasing his capacity for transacting business.

A SHEFFIELD CORNER.

The new building which we illustrate this week is now on the point of completion, being erected in the most central position in the town, at the corner of High Street and the old Churchyard, for the well-known printers, lithographers, and stationers, Messrs. Pawson and Brailsford. Care has been taken in the planning to utilize an irregular but valuable business site, as will be seen from the plan which we give with the illustration. The ground floor is occupied at one corner by Messrs. Pawson and Brailsford's own shop, having one front to Church Gates and another to High Street. Since the drawing was made, the other two shops have been done away with, and a stone arcade of three arches substituted, as that portion of the building will be occupied by the London and Yorkshire Bank. The building has seven floors, including the basement, which is commodious, dry, and well lighted. On the first, second, and third floors are suites of offices for solicitors, accountants, etc., approached from East Parade. The upper and basement floors are for storage and manufacturing purposes for Messrs. Pawson and Brailsford, with hoists. The principal office on the first floor has been let to the Sheffield Stock Exchange. The building is constructed with the best quality of Huddersfield stone from Varley's Warwick quarries, and of specially prepared thin bricks with thick joints, from Fareham, in Kent. The roofs are covered with green Westmoreland slates.—*Building News.*

THE DYING ACHILLES.--A MARBLE STATUE BY ERNST HERTER.

In the International Art Exhibition at Vienna, in 1882, the plaster model of a statue of the dying Achilles was first exhibited. It represents the hero resting on the ground, and supporting his body by his left arm, while he draws the arrow out of his heel with his right

SUGGESTIONS IN ARCHITECTURE.—NEW OFFICES AND BUSINESS PREMISES, SHEFFIELD.—MESSRS. M. E. & C. HADFIELD, ARCHITECTS.

hand. The face expresses the greatest pain. The Empress of Austria was so favorably impressed by this beautiful work of art that she ordered its execution in marble. The artist completed his statue last year and delivered it at Vienna, where it was placed in one of the private apartments of the Imperial Palace. Later on it is to be placed in the Empress' castle near Ischl. The execution of the statue is perfect. The muscles appear full of life, the sinews are contracted, and the blood seems to circulate in the swollen veins. From the forehead to the toe there is not a square inch that does not express life and activity.

Ernst Herter was born in Berlin in 1846. He has produced many noted works of art. His first was "Antigone burying her Brother," the execution of the model of which was ordered by the Emperor William. Among his other works are the "Soldiers' Monument," at Spandau and Brussels, the statue of Alexander, executed in bronze for the National Gallery, and in marble for Dr. Friedberg; the colossal statues of Post and Telegraphy for the Central Post Office in Berlin, the statues of Neptune and Mercury for the Post Office building in the Spandauer Street in Berlin, the reliefs and the bronze portrait of the Emperor William, and the reliefs for the Court House of Potsdam.—*Illustrirte Zeitung.*

THE DYING ACHILLES.—A MARBLE STATUE BY ERNST HERTER.

A GREAT MAGNESIA MINE.

AIGUES-MORTES, on the Mediterranean, is known to all geologists as a remarkable instance of the slow upheaval which is constantly going on in many places. In former times it was a seaport of considerable importance; but it now stands at the head of mud flats stretching more than two miles inland. Partly in consequence of these geological changes, which have rendered the locality convenient for dealing with large quantities of sea water, Aigues-Mortes possesses at the present time features of interest to the engineer, particularly to the engineer occupied in the production of steel. Works of no great magnitude yet, but of certainly growing importance, have been constructed here for the production of magnesia. The mine from which this mineral is extracted is fairly rich and of no inconsiderable extent, being nothing less than the sea itself. With so large a property to draw upon, the company formed to exploit it are free from the apprehension of exhausting their mine before a satisfactory return for the outlay has been obtained. They have, moreover, the great advantage of being able to work upon it in any part of the world where the produce may be required. These circumstances constitute features in the magnesia works of Aigues-Mortes not possessed by every mining undertaking.

The quantity of magnesia in sea water is sufficiently great to render its extraction profitable. In a cubic meter of water there are about two kilogrammes of pure magnesia existing as a chloride or a sulphate. To obtain this in the form of hydrate, the cost only slightly exceeds the value of an equivalent quantity of lime required to effect the transformation, the processes being exceptionally simple. The chemical reactions relied upon to give the magnesia in the uncombined state are these: When milk of lime is poured into sea water, the molecule of chloride of magnesium is broken up, chloride of lime being formed, which remains in solution, and a milky precipitate of hydrate of magnesium is thrown down. Similarly from the sulphate of magnesium, we obtain the same precipitate and sulphate of calcium. But the great bulk of the magnesia exists in sea water as the chloride. The hydrate when calcined assumes two different states, according to the temperature at which the calcination has been effected. If the temperature has not exceeded 900 deg. Fah., the resulting caustic magnesia is capable of resuming its water of hydration, and setting hard like a cement. But if the substance has been raised to a white heat, it no longer retains that property, and is indifferent to the action of water.

The magnesia extracted by these means at Aigues-Mortes is intended to be used as a substitute for dolomite, or magnesian limestone, in the Bessemer process of steel manufacture; and for this purpose it is moulded into the form of bricks. It seems highly probable that these magnesia bricks will in a short time come into general use for this purpose; and such works as those at Aigues-Mortes will then be called into existence in many places. A new and important industry may in this way be established in this country. Equal to lime in infusibility, magnesia is a more perfect type of a refractory substance, and is applicable to every use in which it is not brought into contact with an acid substance in a state of fusion. The ease with which it may be moulded into bricks is also a practical advantage of no small value; and such bricks are greatly superior in many respects to those made of dolomite. A dolomite brick needs an anhydrous cement—usually coal tar is employed for the purpose; it will keep unaltered only a few days, even when every precaution is taken to shield it from atmospheric influences, and it is of too frail a nature to permit of its being handled roughly. But a magnesia brick is similar to one of common clay in all these particulars. In the matter of cost, too, the advantage is on the side of the magnesia brick. Per ton, the latter costs almost exactly twice as much as the dolomite agglomerations; but as 130 lb. of the limestone are required per ton of steel produced, while 40 lb. of magnesia are sufficient for that quantity, the relative cost is as 2 to 3. This is an important merit, and the one that will commend itself most forcibly to the manufacturer of steel. It is, moreover, to be borne in mind that when magnesia is used in the converters the duration of the linings is increased threefold. Possessed of these numerous and great advantages, magnesia bricks can hardly fail to supplant the dolomite in the use to which the latter are put in the Bessemer processes of steel making. It is hoped that a further use of magnesia may be made by employing it as a reagent, in many cases, in place of lime. In such a case, the scoriæ—phosphate of magnesia instead of phosphate of lime—would be reduced to about one-third.

At Aigues-Mortes the sea water is pumped into a large tank of masonry, and an equivalent quantity of milk of lime is run into the tank along with it. The flow, both of water and milk of lime, is continuous during the time of working, the relative quantities of each being calculated to give the requisite proportions. The mixture flows from this tank into two similar tanks in succession, and is briskly stirred in each by agitators driven by steam, or often by horse-power. The precipitate, now in suspension, is to be obtained by filtration, and for this purpose the water is run upon filtering beds. These filtering beds are formed of fine clean sea sand spread over the bottom of shallow excavations about 1,000 ft. long and 16 ft. broad. The magnesia is deposited upon the sand as a heavy tenacious mud, and the supernatant liquid flows off clear at the far end of the bed. When a sufficient quantity has collected, which is known by the sand ceasing to decant properly, the inflow is stopped, and the bed, with its charge of magnesia, is left to dry up in the sun. This takes from twenty to thirty days. Of course, this method of drying can be adopted only in the summer months, and not even then in every climate. But the drying could

be done artificially without adding greatly to the expense. The managers of the works at Aigues-Mortes have now under consideration a plan of this character to enable them to work all through the year. With their present arrangements they are treating 1,000 cubic meters of sea water a day; and they obtain from the filtering beds an average of 2 lb. of magnesia per square yard of surface per day. The extent of the beds is being increased to treat a larger quantity of water in the coming summer season. The present output is six tons a week. The dried magnesia slime is stowed away in sheds, to be calcined and moulded into bricks, the manufacture of which is carried on throughout the year.

CYANIDE OF POTASSIUM.

Cyanogen, C_2N=26, discovered by Gay-Lussac 1815, is a compound radical, which, in its chemical character, is analogous to the halogens chlorine, bromine, and fluorine, and assumes in the formation of combinations the part of an elementary substance just as ammonium NH_4, another compound radical, will do. Cyanogen never occurs naturally in its pure state, but is found as a sulphocyanide in the saliva of man, and but rarely in some vegetable matter; but it can be formed from many organic and inorganic bodies by various processes. It is a gas, being composed of carbon and nitrogen in the proportion of two equivalents of the former to one equivalent of the latter=C_2N; and in its capacity of a quasi element is designated by the symbol Cy. It is inflammable, burns with a beautiful purple flame, generating carbonic acid, and setting free nitrogen. Its solutions are easily decomposed; they turn turbid and brown, resulting in a series of newly formed combinations, as hydrocyanic, cyanic, oxalic, carbonic, or formic acids, urea, and ammonia.

Cyanogen combines with other elements; with metals into cyanides, and with hydrogen into hydrocyanic acid, which is extremely poisonous, and known by the name of prussic acid, and is in every way analogous to hydrochloric acid.

Gay-Lussac prepared pure cyanogen by heating in a small retort the salt called cyanide of mercury. Similarly to the liberation of oxygen from oxide of mercury, the cyanide of mercury is divided into its elements, cyanogen being set free, while metallic mercury, paracyanogen, and carbon remain. This process has proved to be of the greatest importance in organic chemistry, has opened a large field for investigations, and has shown us a compound which is physically and chemically analogous to an element, in consequence of which the doctrine of compound radicals has been introduced.

Cyanogen has a powerful affinity for the alkali metals; their combinations are soluble in water, and proceed when a base is neutralized by hydrocyanic acid. When potassium is heated in cyanogen gas, it takes fire, burning in a very beautiful manner, resulting in cyanide of potassium, KCy. Passing the vapors of hydrocyanic acid into a cold alcoholic solution of potash, a chemically pure and crystallized cyanide can be obtained.

Liebig has published a very easy and excellent process, which, however, does not yield a pure article, it being always mixed more or less with cyanate of potash. Eight parts of ferrocyanide of potassium (yellow prussiate) are rendered anhydrous by gentle heat, and intimately mixed with three parts of dry carbonate of potash. The mixture is thrown into a red-hot earthen crucible and kept in fusion until gas ceases to be evolved, and the fluid portion of the mass becomes colorless. The crucible is left at rest for a moment, and then the clear salt decanted from the heavy black sediment, which is principally metallic iron in a state of minute division. The reaction is explained by the following equation: $2(2KCy+FeCy)+(2KO,CO_2)=5KCy+KO,CyO+2Fe+2CO_2$. Ferrocyanide of potassium heated to whiteness in a nearly closed earthen vessel evolves nitrogen and other gases, and leaves a mixture of carbon, carbide of iron, and cyanide of potassium.

For this process Donovan recommends the use of a wrought iron mercury bottle. When no more gas issues, the iron bottle is cooled, and to get at the product, is cut by chisel and sledge-hammer.

Cyanide of potassium forms colorless cubic or octahedral crystals. The commercial article comes in white, opaque, amorphous masses, of a sharp, alkaline, bitter taste and an alkaline reaction. It exhales, when exposed to air, the peculiar odor of hydrocyanic acid. It is readily soluble in water, but sparingly in alcohol, is decomposed by the weakest acids, even the carbonic acid of the atmosphere. The usual impurities found in cyanide are hydrate, carbonate, cyanate, and formate of potash. It is a powerful solvent for oxides and cyanides of many metals, and especially for the haloids of silver, finds therefore employment in photographic and electrometallurgic operations, especially in galvanoplasty and electro-plating. To use it as a fixing agent for gelatine-emulsion plates, it must be perfectly pure. Any of the impurities mentioned would lead to a weakening or destruction of the film. It is a powerful poison, acting upon the system like hydrocyanic acid, fatally in most cases. Its effects are loss of sense, smallness of pulse, contraction of the pupils, convulsions, and death. Antidotes are chlorine water or chloride of lime; diluted ammonia may be given internally and the vapors inhaled, and cold embrocations. Messrs. Smith, of Edinburgh, have recommended a mixture of the sulphates of protoxide and sesquioxide of iron to be swallowed after a solution of carbonate of potassa, thus converting the poison, with the antidotes, into Prussian blue.—*E., Photo. Times.*

IMPROVED POTASH DEVELOPER FOR COLLODION EMULSION PLATES FOR TRANSPARENCIES, ETC.

For the benefit of those who work collodion emulsion (either washed or unwashed) for lantern slides, etc., this developer will be found to surpass anything that has hitherto been published. Carbonate of ammonia is a very unstable salt, and two samples can scarcely be obtained alike; so that the results given by different samples are at times anything but pleasing, and very confusing to one who is, perhaps, not well up to the making of lantern slides and transparencies. Carbonate of ammonia in the developer works well if a good sample can be obtained, and gives a very nice effect, but on the whole I give the preference to the potash as given below, for with it almost any range of color and tone can be obtained.

I make two solutions as follows:

SOLUTION P.

Pyrogallic acid	96 grs.
Absolute alcohol	1 oz.

SOLUTION A.

Potassium carbonate	300	grains.
" bicarbonate	150	"
" bromide	60	"
Soda acetate	120	"
Water	12	ounces.

To develop put into a clean measure:

Solution P	10 to 20 mins.
Solution A	2 drachms.
Water	2 drachms.

This is at once poured over the plate as soon as it is washed free from alcohol. Before development, the plate is flooded with alcohol and then soaked in water until the latter drives off the alcohol and is evenly absorbed in film.

When I was first making experiments with the carbonate to get rid of the uncertainty of the ammonium salts, I made up the solution from a bottle of potassium carbonate which had not been opened for at least six months. I made up at the time about twenty-four ounces, as I had a lot of work in hand, and it worked splendidly, and I was delighted with it; when I had used all the solution I made another fresh lot up, but lo and behold, its action was totally different; instead of giving, as before, a warm, ruddy tone, it was a poor, wretched, smoky, dirty color, and I could not make it out. I tried for days and days; tried different samples of carbonate, but all to no purpose—nothing but a poor, miserable color. A cause I knew there must be, and my mind was set upon hunting it out; and after several weeks I hit upon it, in this way: it occurred to me that as the bottle I first used from had not been used from for at least six months, I thought possibly that the upper layer might have become converted into *bi*carbonate, and if so, the salt used was in reality carbonate and bicarbonate mixed, and it was very easy to make the experiment by adding bicarbonate, which I at once did; and, to my delight, I got the color again, and far better; to further test it, I made up several solutions from several samples as before, the results were all the same—a fine warm color that could be toned by platinum to any color required; it only remained, then, for me to settle on the proportions, which took me some little time to do, which is as I have given above.

I find it perfection for negatives of ordinary density, and it also works well with very intense negatives, provided a full exposure be given. But if very thin negatives are used, the difficulty can be easily overcome by doubling the bicarbonate, *i. e.*, three hundred grains instead of one hundred and fifty; and for negatives which are merely ghosts the bicarbonate can be further increased with advantage. With the bicarbonate increased, any amount of contrast can be readily obtained. When showing the above formula to a friend a short time since, he asked me what made me so stupid as to combine carbonate and bicarbonate, as every one knew they were both the same; the chemist where he dealt had told him so. I told him that the sooner he cut his chemist's acquaintance the better, and go to a practical man for his p iotographic chemicals. The bicarbonate acts as a restrainer in a very peculiar way. I tried using bicarbonate only, but to no purpose, leaving out the bromide, and I found that the proportions as given to be the best. With this developer there is less tendency of the film to slip. Negatives can be obtained with very short exposures with collodion emulsion by leaving out the bicarbonate, and increasing the carbonate to three hundred and sixty grains; in negatives it is not a question of color. In making transparencies in the camera, I find it best not to stop the lens down too much, only just sufficiently to get perfect sharpness, if warm tones are required; if stopped down to the smallest stop, no matter how long the exposure, the tone is never so good.—*William Brooks, Brit. Jour. of Photo.*

HOW TO MAKE GELATINO-CHLORIDE PAPER FOR PRINTING WITHOUT DEVELOPING.

The process is so simple that any one with the least knowledge of photography can make their own ready sensitized paper.

A formula that I have found to answer well, giving results closely resembling albumen, and printing an excellent chocolate red which may be toned to any extent, is:

Gelatine (Nelson's No. 1, and Coignet's, equal parts)	175 grains.
Chloride of ammonium	18 "
Rochelle salts (Potassio tartrate of soda)	50 "
Nitrate of silver	75 "
Methylated alcohol	¼ ounce.
Water	5 ounces.

To make: First obtain a colored bottle, orange-yellow by preference, but "greenery-yallery" will do; the operations can then be performed in ordinary daylight. Of course, if a white bottle be used, a red or yellow light of some kind must be adopted. Pour in the five ounces of water, add the salts, and then all the gelatine; leave this about fifteen minutes to soak, then apply heat, and melt; when at a temperature of about 100 Fahr., add the silver, in crystals, all at once, put in the cork, and gently agitate the bottle for several minutes. The emulsion is very thin and transparent at this stage, as the organic salt forms slowly; it must now be kept at a temperature of about 100 Fahr. for ten minutes, when the alcohol should be added, and after standing for a short time, the emulsion will be found much thicker, and can be poured out to set, or can be used upon the paper at once without washing, as preferred. A very slight washing suffices, all that is necessary, or in fact desirable, is to cut the emulsion into threads and soak for a short time in two or three changes of water, add ing a little more alcohol after remelting.

The paper may be coated by rolling the paper face outward upon a light roller, then laying upon the warm emulsion, allowing it to unfold itself; at the same time drawing the paper slowly over the emulsion, and then laying upon some level surface to set. I, however, prefer to wet the paper thoroughly with warm water, and squeegee it lightly on to a piece of glass, pouring the emulsion on to the wet paper, upon which it flows well, and then putting upon a level surface to set, afterward removing from glass and pinning up to dry. About three drachms will be required for a surface 8 × 5. Good Rive's answers well, and in all probability the paper will curl up somewhat as it dries; this, however, is of no consequence, as this is easily removed, and the paper rendered quite flat, by rolling face outward upon a moderate-sized roller, and keeping in that position for a time.

I was some time before arriving at a satisfactory method of toning, as, although the prints looked just the right color, they obstinately refused to tone in a satisfactory manner in any ordinary toning bath. This difficulty I have now overcome, and the following method will give any desired tone: Print a little deeper than required: when finished, wash slightly, and then immerse the prints in a solution of sulphocyanide of ammonium, twenty grains; water, one ounce; then place, without washing, in toning bath; the acetate of soda and borax bath works well, and gives good tones. If time is an object, the prints may be fixed in five minutes in a solution of hypo one part, water six parts. I however prefer a weaker solution, consisting of hypo one part, water sixteen parts, in which it is necessary that the prints be left for about fifteen minutes, and moved occasionally, as the organic salt takes longer to fix out than the haloid salt, though this depends, to a certain extent, upon the quantity of gelatine used: the larger the proportion of gelatine, the longer the time required in the hypo. If not fixed properly, a reddish-gray stain, quite fatal to the print, will be left. So far from this being a drawback, it may be taken as a positive advantage, as the prints *must* be properly fixed, and are therefore all the more likely to be permanent. The prints must not be examined in white light; a sheet of thin yellow paper over the window is, however, all that is required. After fixing, wash well, and mount while wet, upon glass that has been rubbed with French chalk, and strip off when thoroughly dry. Alum can be used if thought desirable, but in my own practice have as yet found no necessity for it; at the same time, in warm weather its use will, of course, be compulsory.

The advantages of this paper are many; it is, for instance, very suitable for travelers, as it seems to keep indefinitely; prints considerably quicker than albumenized paper; can be toned any time after printing; promises to be absolutely permanent. I have had a print, one half covered with thick orange paper, the other half uncovered, exposed to strong sunlight for several days without being able as yet to detect the slightest difference in the color of the two halves; and negatives can be printed from before varnishing, etc.

I may add in conclusion that the above instructions must be strictly adhered to, and results will then be obtained excelling albumenized paper in rapidity and, at least, equaling it in excellence.—*J. Barker, Brit. Jour. of Photo.*

THE ROLLING PLANIMETER.

By F. H. Reitz.*

A large number of new planimeters have been introduced of late years, and accounts of these have from time to time appeared in this journal. Among these may be mentioned the various constructions of Amsler's planimeter, Hohmann-Coradi's precision planimeter, Günther's planimeter, Kloth's planimeter, and, lastly, Hohmann-Coradi's suspended planimeter. To these may now be added the *rolling planimeter*, an instrument which may be described as the outcome of an extensive series of protracted experiments made by Herr Coradi, which led him to the peculiar solution of the problem we are now going to explain.

In the new instrument, four distinct features are embodied, each of which may be set down as a *sine qua non* of a proper construction of a planimeter. In the first place, the unit of the vernier is so small that surfaces of quite diminutive size may be determined by it with sufficient accuracy; and in this respect the new planimeter seems to have stolen a march on its older rivals. Secondly, the space to be encompassed at one fixing of the apparatus is very large in proportion to the dimensions of the apparatus, more especially in the case of long-stretched diagrams or drawings, which occur very frequently in practice. Thirdly, the results are scarcely ever affected by the nature of the surface of the paper on which the diagram is drawn or printed; and, fourthly, the whole arrangement of the instrument is such as to admit of all its parts being kept in good working order for a great length of time.

The engraving is a perspective view of the instrument, taken from a photograph.

The frame, B, is supported by the shaft of the two rollers, R^1, the surfaces of which are fluted in a peculiar way. To the frame, B, are fitted the disk, A, and the axis of the tracing arm, F. The whole apparatus moves in a straight line to any desired length upon the two rollers resting on the paper, while the tracing point travels around the diagram of which the measurement is required.

Upon the shaft that forms the axis of the two rollers, R^1, a minutely divided miter-wheel, R_2, is fixed, which gears into a pinion, R_3. This pinion, being fixed upon the same spindle as the disk, A, causes the disk to revolve, and thereby induces the rolling motion of the entire apparatus.

The measuring roller, E, resting upon the disk, A, travels thereon to and fro, in sympathy with the motion of the tracing arm, F, this measuring roller being actuated by another arm fixed at right angles to the tracing arm, and moving freely between pivots. The axis of the measuring roller is parallel to the tracing arm, F. The top end of the spindle upon which the disk, A, is fixed pivots on a radial steel bar, C C_1, fixed upon the framing, B.

According to the general theory of planimeters furnished with measuring rollers, it is immaterial what line the free end of the tracing arm travels over; nevertheless, there is some practical advantage in the construction of the apparatus to be obtained by causing that end to travel as nearly as possible in a straight

* Translated from the *Zeitschrift für Vermessungs-Wesen* (The Surveyor's Journal). 1884. No. 20.

line. Still, for the reason given heretofore, it is obvious that a slight deviation from the straight line would not involve any inaccuracy in the result.

Seeing that the fulcrum of the tracing arm keeps traveling in a straight line, it appears advisable, in evolving the theory of the apparatus, to assume a rectangular system of co-ordinates, and fix upon the line along which that fulcrum travels as the axis of abscissæ.

The passage of the tracing point around the perimeter of a diagram may be looked upon as being made up of two motions, one parallel to the axis of abscissæ and the other at right angles to that axis. Inasmuch as the latter of these two motions, in the direction of the axis of ordinates, is, after all, but an alternate motion of the tracing point, which takes place in an equal ratio, until the tracing point has returned to the spot it had started from, no one point of the circumference of the measuring roller is continuously moved forward in consequence of this motion. Therefore, it is only necessary to take the differential motion of the tracing point in the direction of the axis of abscissæ into consideration.

In the diagram, the same letters of reference denote identical parts or organs as in the upper cut; the letter D denoting the distance between the fulcrum of the tracing arm and the axis of the disk, A. In connection with the diagram, it remains to be determined what must be the quantity representing the motion of a point on the surface of the measuring roller, E, while the tracing point travels to the extent of $d\,x$. If the construction of the planimeter be correct, the quantity referred to must appear as the product of the differential quotent of the surface with reference to rectangular co-ordinates ($y\,d\,x$), multiplied into a constant derived from the dimensions of the instrument.

It is obvious that as the tracing point moves to the extent of $d\,x$, a point in the circumference of the rollers of such a radius as R_1 has must also be shifted to the extent of $d\,x$. This being so, any point in the pitch-line of the miter-wheel, R_2, must necessarily move to the extent of $d\,x\frac{R_2}{R_1}$. By the same motions, a point of the disk, A, is moved at a distance $a\,d$ of the layer of the measuring roller to the extent of $d\,x\frac{R_2}{R_1}\times\frac{a\,d}{R_3}$. In Fig. 2, this quantity is denoted by $a\,b$, therefore:

$$a\,b=d\,x\frac{R_2}{R_1}\times\frac{a\,d}{R_3}\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

In consequence of the position of the axis of the measuring roller, the motion of the disk, A, to the extent of $a\,b$ produces a further shifting of a point in the circumference of the measuring roller to the extent of $c\,b$, while the measuring roller itself travels to the extent of $a\,c$. It, therefore, becomes necessary to find a formula for the value of $c\,b$.

It will be readily perceived that $c\,b=a\,b\ sin\ (\alpha+\beta)$, seeing that $d\,a\,b=90°$ and $c\,a\,g=90°$, wherefore $c\,a\,f=\alpha$ and $f\,a\,b=\beta$. Now we have $sin\ (\alpha+\beta)=sin\ \alpha\ cos\ \beta+cos\ \alpha\ sin\ \beta$; again:

$$sin\ \alpha=\frac{y}{F},\ cos\ \alpha=\sqrt{1-\frac{y^2}{F^2}},\ sin\ \beta=\frac{a\,f}{a\,d}=\frac{a\,g\ sin\ \alpha}{a\,d}=\frac{a\,g\frac{y}{F}}{a\,d}$$

$$cos\ \beta=\frac{d\,f}{a\,d}=\frac{D-a\,g\sqrt{1-\frac{y^2}{F^2}}}{a\,d}.$$ If these values be substituted in the equation of $c\,b$, we find:

$$c\,b=a\,b\left(\frac{y}{F}\times\frac{D-a\,g\sqrt{1-\frac{y^2}{F^2}}}{a\,d}+\sqrt{1-\frac{y^2}{F^2}}\times\frac{a\,g\frac{y}{F}}{a\,d}\right)=$$

$a\,b\,\frac{y}{F}\,\frac{D}{a\,d}$; again, substituting the value of $a\,b$ as per 1, we find:

$$c\,b=y\,d\,x\frac{D\times R_2}{F\times R_1\times R_3}\ldots\ldots(2)\quad Q.\ E.\ D.$$

Seeing that the sum of $c\,b$ is equal to the difference in the reading multiplied into the circumference of the measuring roller, and that $\int y\,d\,x$ is equal to the area of the diagram traced around, we find, by integrating equation 2 and setting down the circumference of the measuring roller as U, the area of the diagram as J, and the difference in the reading as N, that:

$$J=N.\ \frac{U\,R_1\,R_3\,F}{R_2\,D}\ldots\ldots\ldots\ldots\ldots\ldots(3)$$

The formula 3 shows that the distance of $a\,g$ of the roller from the fulcrum of the tracing arm, g, is immaterial, and does not affect the results obtained by the use of the instrument.

Messrs. Luckhardt & Alten, of Cassel, Germany, supply these instruments.

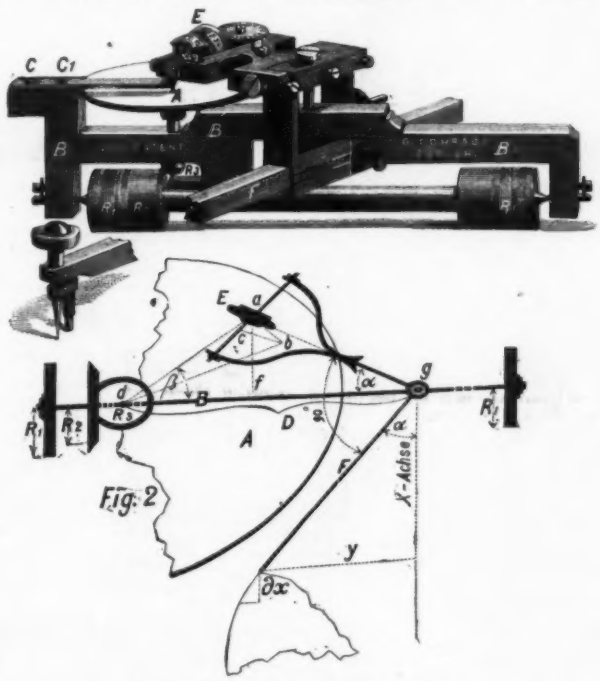


Fig. 2

THE ROLLING PLANIMETER.

THE PRODUCTION OF AMMONIA FROM THE NITROGEN OF MINERALS.*

By Mr. GEORGE BEILBY.

THERE is probably room for considerable difference of opinion as to the origin of combined nitrogen in the early stages of the world's development, but it will be pretty generally admitted that the available sources of combined nitrogen at the present day are all, either directly or indirectly, organic. Cyanogen compounds and their derivatives, ammonia salts and alkaloids, nitrates and oxides of nitrogen, are invariably produced from nitrogen which has previously existed in the combined form in organic tissues. The vast stores of such nitrogen contained in beds of coal and peat must, as far as we can see at present, remain in the future the main source from which the supplies for industrial use will be obtained. Owing to the abundant supply of natural nitrate of soda in Chili and elsewhere, it has hitherto been quite unnecessary to devise any artificial process for the production of nitric acid or nitrates. The guano deposits of South America were for many years the chief source of the ammonia salts used in agriculture, and caused the ammonia produced in gas making to be looked upon as a by-product, only to be worked up under favorable circumstances; the industrial production of ammonia for its own sake was therefore not seriously attempted. These facts must, to a large extent, be held to account for the lack of a vigorous and rational treatment of the subject of ammonia production from the vast stores of combined nitrogen existing in the old organic deposits of the peat and coal fields. Turning, however, to the technology of cyanogen compounds, we find a much fuller record of technical research. The industrial world needed cyanides, and as no convenient natural stores of them had been provided—as was the case with nitrates and ammonia salts—cyanides had to be produced artificially. In the researches on the manufacture of cyanides, we might fairly expect to find the germ of a rational knowledge of such of the properties of organic nitrogen as are related to its conversion into ammonia. This expectation is not disappointed; the records of the researches of English, German, and French chemists in this field are not only deeply interesting, but they are both instructive and suggestive.

The earliest studies on the behavior of the nitrogen of organic substances during destructive distillation were made in this connection, and it was then first recognized that the temperature of distillation had a most important influence on the ultimate distribution of the nitrogen among the products of distillation and the residual charcoal. Karmrodt found, in carbonizing horn, that at three temperatures, ranging from a low red to a white heat, the residues contained respectively 7, 5, and 2 per cent. of nitrogen, the last resulting from the highest temperature. The significance of such a fact as this, as bearing on ammonia production, evidently did not appear to the investigators, who were simply bent on devising an economical process for the manufacture of cyanides, and to whom the inevitable production of ammonia was an evil to be as far as possible minimized.

The rapid exhaustion of the guano deposits, and the increasing consumption of ammonia salts for agricultural purposes, so acted on the ammonia market that, in the year 1879, the price of sulphate of ammonia had risen to £20 per ton. This high price occurring along with a general fall in the value of several of the commodities produced at the same time or by the same processes as ammonia, formed a powerful stimulus to producers of ammonia to increase their output, and at the same time roused the interest of those who, like the owners of blast furnaces and coke ovens, had hitherto allowed large quantities of ammonia to go to waste. The gas companies had for years been perfecting plant for washing out the ammonia from their gas, and the increased output thereby brought about must have been very considerable.

Iron and coke makers turned their attention with renewed interest to the treatment of the gases from their furnaces and ovens for the recovery of ammonia. These efforts were directed to the recovery from the products of destructive distillation of the ammonia naturally resulting from that operation. It is now pretty generally understood that in destructive distillation, as ordinarily practiced in the gas manufacture, only one-sixth to one-twentieth of the nitrogen of the material distilled is obtained as ammonia. This important fact was noted in more than one standard work on applied chemistry, but attracted no attention either in scientific or technical circles.

Dr. Lunge, in his work on "Coal Tar Distillation," published so recently as 1882, quotes a table of analyses by Dr. Meymott Tidy, showing the amount of nitrogen in various coals, and comparing the possible with the actual ammonia yields of the gas companies. The result of his comparison is to show that, in illuminating gas making, only one-sixth of the total nitrogen was obtained as ammonia.

My own interest in the subject dates from 1870, when Mr. A. R. Gillespie, managing director of the Oakbank Oil Company, suggested that I should analyze all the shales then known to exist in the Midcalder field, both those which were considered worth working for the paraffin products and those which were not. It was thought possible that some of the poorer oil shales might yet be sufficiently valuable for their ammonia to admit of their being profitably worked. The determination of the nitrogen in these shales showed that, by the process of distillation as then practiced, only one-sixth of the nitrogen was obtained as ammonia. The fate of the missing five-sixths at once excited our interest, and the research was carried on until the whole was accounted for.

As oil shales are practically unknown in England, a few words of description at this point may make clearer what is to follow. The oil shales of Scotland are found below the coal measures, and are generally associated with marls, limestones, and sandstones. The specimens before you will show you how unlike coal in appearance the shales are. They are generally of a brown or gray color, the richer portions are tough, and cut like leather, while the poorer are stony and slate-like. They contain a very large percentage of mineral matter, sometimes as much as 80 per cent., and generally about 73 per cent. When heated to redness in a close vessel, true shales do not soften or cake, the pieces alter neither in size nor shape, but after all the volatile matter is distilled off, the residue or spent shale, which is soft and black, has still the outward form of the original shale. There are four principal seams, or groups of seams, worked in Scotland; among these, one of the best defined and most extensively worked is the Broxburn shale, so called from having been first found in Broxburn, in Linlithgowshire. It is not, however, confined to that particular district, but is at present worked at points as much as 12 to 15 miles apart. This shale was in regular use at Oakbank in 1870, and special attention was therefore given to the study of the behavior of its nitrogen. By the process of distillation as practiced at that date, the shale was subjected for from 12 to 20 hours to a low red heat, in iron retorts, a current of steam being passed through the retort during the distillation. The volatile hydrocarbons and other vapors were cooled by passing through condensers. The distillate from one ton of shale consisted of about 30 gallons of crude paraffin oil and 60 to 80 gallons of ammoniacal liquor, the large volume of the latter being due to the condensation of the steam passed through the retort. This ammoniacal liquor contained ammonia equal to about 15 lb. of sulphate. The primary object of the use of a current of steam in the retort was to obtain a maximum yield of paraffin products, through the protective action of the steam in sweeping away the hydrocarbon vapors as they were formed, and before they could be decomposed by overheating; but it is quite certain that this use of steam increased the yield of ammonia, the gain probably amounting to five or six per cent. of the original nitrogen. The coke or residue of this shale (specimens exhibited), known as spent shale, was, in 1870, sent to the refuse heap as of no value; but, in the three following years, the successive efforts of Mr. Wm. Young and Mr. N. M. Henderson resulted in the invention of the Henderson retort, in which, by means of ingenious mechanical contrivances, the exhausted residue, or spent shale, was dropped while still hot into a slow combustion furnace, in which the small percentage of carbon, associated with a very large amount of earthy matter, was made to supply a large proportion of the heat necessary for the distillation of the shale. The ash, or earthy residue, was now obtained practically free from fixed carbon, and was sent to the refuse heap.

Returning now to the researches of 1870, analysis of the Broxburn shale showed that it contained 0·72 per cent. of nitrogen, and that by the system of distillation then followed, the distribution of this nitrogen among the residue and products was such that of 100 parts of nitrogen in the shale—

17·0 parts appeared as ammonia in the watery distillate.
20·4 parts appeared as alkaloidal stars in the oil.
62·6 " " in the spent shale.

Or, expressing these proportions in actual numbers, and calculating the nitrogen into its equivalent of sulphate of ammonia, the following results are obtained:

One ton of shale contains nitrogen equal to 74·8 lb. of sulphate of ammonia.	
The watery distillate contains ammonia equal to	12·7 lb.
The alkaloidal tars in the oil contain nitrogen equal to	15·3 "
The "spent shale" or coke contained nitrogen equal to	46·8 "
	74·8 "

The knowledge thus gained was the base from which

* Paper read before the Society of Arts on February 12, 1885.

all our subsequent researches were planned, and many efforts were made to win at least a portion of this hitherto unworked store of nitrogen. The problem which, in the light of present knowledge, seems so simple was necessarily looked at from the oilmaker's point of view. From that standpoint, the value of the paraffin products being five times that of the ammonia, efforts were most naturally directed to the simultaneous improvement of ammonia and paraffin produced. Now, the first investigation had shown that one-fifth of the total nitrogen of the shale went to the formation of complex basic substances in the oily distillate, from which they were ultimately separated by chemical treatment, and were then thrown aside as of little value, or were used as fuel. There was thus the double loss, of the nitrogen, which might have been ammonia, and of the carbon and hydrogen, which might have been paraffin or oils. It was natural, therefore, that the nitrogen in the oil should first attract attention, and that attempts should be made to gain an increased yield of hydrocarbons and ammonia simultaneously. The simpler and more stable bases, piccoline, pyridene, etc., were found quite refractory, except under such heroic treatment as inevitably sacrificed the hydrocarbons. By a modification of Berry's cyanide process it was possible to convert the basic nitrogen into cyanides, but, of course, with complete destruction of the associated hydrocarbons. The more complex nitrogenous substances, on distillation, tend to break up into ammonia, simpler bases, and hydrocarbons; but the proportion of ammonia obtained by a single distillation is very small.

The use of slaked lime in the shale distillation was very fully and practically tested, but it was found that at the temperature most suitable for oil distillation, no gain of ammonia was brought about. On the other hand, the crude paraffin oil was distinctly purer and more easily refined. Though this result does not at first seem in accord with results recently obtained by the use of Cooper's coal lining process in gas making, yet in reality the two results are not inconsistent. In the case of limed shale, the usual current of steam was passed through the retort during distillation, and the water of hydration of the lime in no way altered the condition of things within the retort. But the case of limed coal in a gas retort is altogether different, for there no current of steam is passing through the material. True, most of the oxygen of the coal comes off as water, but this probably occurs at a very early stage of the distillation; so that the water of hydration of the lime, coming off at a comparatively high temperature, does introduce a new condition of things within the retort. The most effective method of applying lime to the shale was found to be by washing it over with a thick milk of lime, the coating of lime being allowed to dry before the shale was put into the retorts.

As the result of these attempts to gain an increased yield of ammonia, simultaneously with a maximum yield of paraffin products, showed pretty conclusively that the end could not be attained by any simple or single process, the necessary and favorable conditions for the attainment of the one object being almost antagonistic to the others, it then, for the first time, occurred to Mr. William Young and the author to treat the residue, or spent shale, to a supplementary operation of steaming after the oil distillation was finished. In all of the earlier trials the two operations, the distillation and steaming, were conducted in the same retort, and the temperature employed in the latter operation was little, if at all, higher than that suitable for oil making. It was found that, by continuing this steaming for several days, a considerable proportion of the nitrogen of the spent shale came off as ammonia.

During the steaming a small quantity of gas came with the steam, showing that some slight decomposition of steam was taking place within the retort, but the fixed carbon of the spent shale, after the operation, was only diminished to a slight extent. This experiment showed that it was possible to obtain a large quantity of the nitrogen of the spent shale, but the method of doing so was evidently quite inapplicable commercially.

The cost of plant forbade the devotion of two or three days to the steaming of every retortful of shale. The ordinary operation of distillation only occupies twelve to twenty hours, so that the addition of from forty-eight to seventy-two hours for each operation would have reduced the power of the plant to one-third, and would thereby have trebled the working costs. The ammonia gain would have been more than swallowed up in these increased costs. Ultimately, we resolved to try how far the operation could be accelerated by the use of a higher temperature for the supplementary operation, and with this object a retort was fitted up, as shown in Fig. 1.

The upper part of this retort consisted of an iron tube 12 inches in diameter, closed at its upper end by a hopper and bell, and provided with a branch or exit pipe for oil, vapors, and gases. The flange on the lower end of the iron tube was secured to the upper end of a 13 inch fireclay tube five feet long, the lower end of which was jointed to a short iron flanged tube or hat piece, the flange of which, resting on a strong iron sole plate, supported the whole retort—the lower end of the hat piece, dipped into water in a shallow iron tray, so as to lute the retort. This double retort, iron above and fireclay below, was built in a double oven heated by a coal fire, the fire gases being so led as first to heat the fireclay retort to a bright red heat, the partially spent gases being afterward led round the iron retort, heating it to a very dark red. The branch or exit pipe was connected to air condensers of ordinary form. A steam pipe was led into the lower end of the retort or hat piece.

In beginning to work this retort, the heats having been raised to the proper points, the fireclay retort is filled up to the junction of the iron retort with spent shale, on the top of which broken shale is introduced, until the iron retort, is filled to the hopper, which is closed from the outer air by the bell valve. The steam entering the lower end of the retort, and passing through the red hot material in the fireclay portion, is highly superheated, and rapidly conveys heat to the raw shale in the upper retort, which is further heated by the flue gases outside. The oil vapors and steam passing off by the exit pipe are cooled and condensed, and are collected in tanks. The shale at the lower end of the iron retort is first exhausted of its hydrocarbons, and the removal or a portion of the material from the trough by a suitable rake moves downward the whole column within the retort, so that the portion of shale exhausted of its oil products is now brought into the more highly heated clay retort, and being subjected to the current of steam a large part of its nitrogen is converted into ammonia, which passes away with the steam and oil vapors. As the column of material is moved downward by the removal of portions from the trough, fresh shale is introduced by the hopper at the top, but this downward stream is so regulated that no shale containing undistilled oil comes down into the highly heated retort.

The experimental retort was intended to answer two important questions: 1. Was it possible to win the increased yield of ammonia, by the application to the spent shale of a higher temperature, without an unreasonably heavy expenditure of time and labor? 2. What influence would this supplementary treatment of the spent shale have upon the primary process of paraffin oil distillation which was to take place in the upper part of the apparatus? With reference to the second question, it has already been pointed out that, at the best, ammonia is only a secondary product from shale distillation. In 1873, the value of the paraffin oil pro-

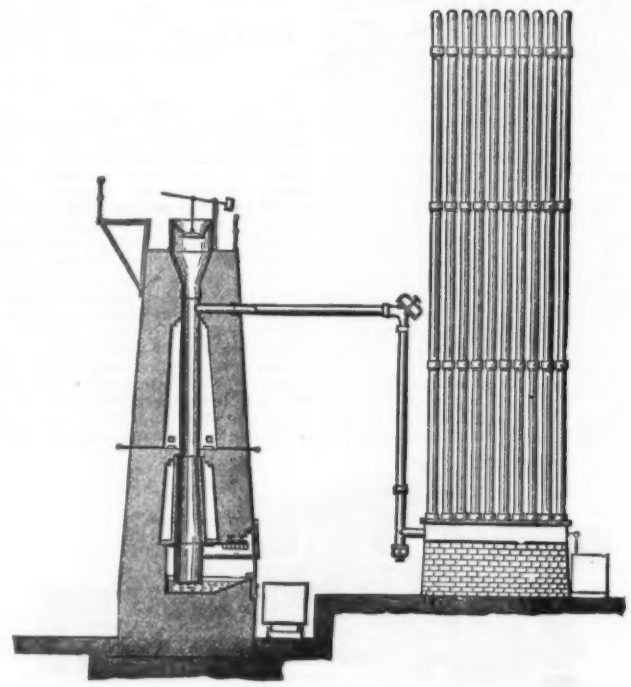


FIG. 1.

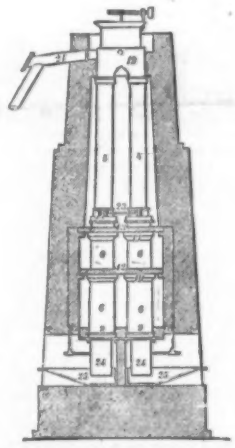


FIG. 2.

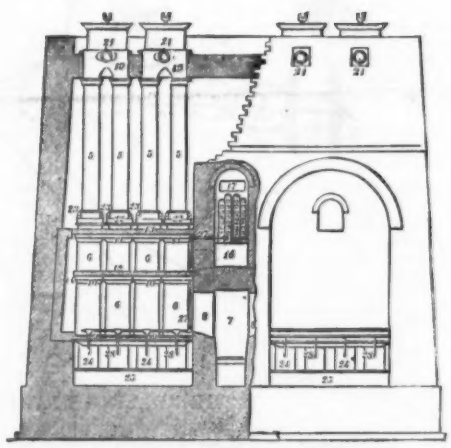


FIG. 3.

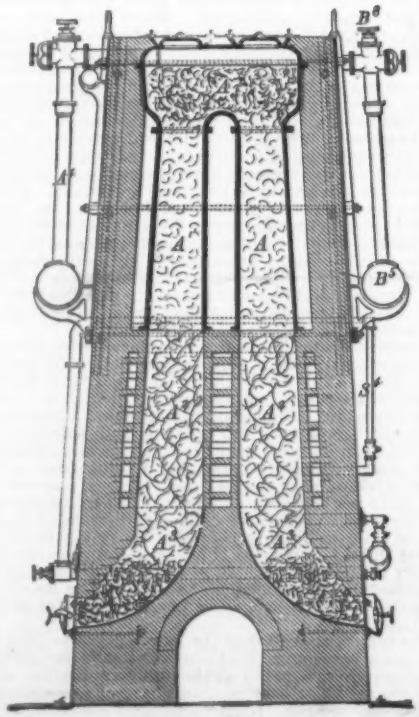


FIG. 4.

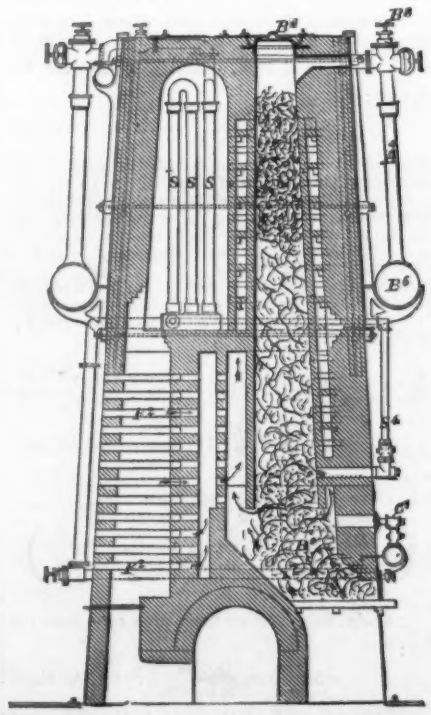


FIG. 5.

RETORTS FOR PRODUCING AMMONIA FROM COAL AND SHALE.

ducts of a ton of shale was about 25s., while to-day it is only one-half, or 12s. The value of a maximum yield of ammonia may be taken as 3s. to. 4s. per ton. From these figures, it is evident that any gain of ammonia which involved a sacrifice of paraffin products might be purchased too dearly. The working of this experimental retort gave a most satisfactory answer to both of these questions. It was found that the double operation of extracting the paraffin oil and recovering the ammonia of the spent shale could be accomplished in from twenty to twenty-four hours.

Further, instead of a lower yield of paraffin products, a decided gain in the most valuable of these products was realized. This latter result was evidently brought about from the distillation of the shale being, to so great an extent, effected by the internally applied heat brought to it by the larger volume of highly heated steam or gas, this rapid current of gas and vapor sweeping away and preserving the newly-formed hydrocarbon vapors. As to the actual yields of ammonia realized by this retort, they reached as much as 56 lb. of sulphate per ton of shale, and the distribution of the original nitrogen was modified as follows: One ton of shale containing nitrogen equal to 74·8 lb. of sulphate of ammonia gave watery distillate containing nitrogen equal to 55·0 lb. of sulphate of ammonia; oily distillate containing equal to 15·3 lb of sulphate of ammonia; spent shale containing nitrogen equal to 4·5 lb. of sulphate of ammonia.

Although this result could be obtained at will in the experimental retort, putting through 10 cwt. of shale per day, certain features of the process, which are now to be more fully described, rendered it improbable that such perfect results could be realized in working on a really large scale. Very early in this course of experiments it was noticed that whenever the yield of ammonia from the retort rose above 25 lb. of sulphate per ton, many of the pieces of spent shale coming from the retort were white and hard instead of soft and black, and on breaking these pieces it was found that this whitening entered from an eighth to half an inch into the substance, a soft black core being generally found inside the piece. This whitening was caused by the burning away by the oxygen of a portion of the steam passing through the retort, of the 14 or 15 per cent. of fixed carbon ordinarily contained in the spent shale from simple oil distillation. It was found, by repeated analyses, that as long as the residue contained carbon, so long did it also contain nitrogen; that only when every trace of carbon was burnt away was the nitrogen completely driven out.

It was also found that if a sufficiently full current of steam was kept up within the retort, little or none of the nitrogen of the spent shale was lost as free nitrogen. An average sample of the whole residue from a day's retorting, on analysis, gave an amount of nitrogen which exactly supplemented the ammonia actually obtained. All this was favorable to the success of the process, but there remained one point, important but unfavorable. Spent shale contains about 85 per cent. of mineral ash, consisting of silicates of varying fusibility. As long as the 15 per cent. of fixed carbon is intimately mixed with these silicates, the mass is nearly infusible; but whenever any large proportion of the fixed carbon has been burned away by the oxygen of the steam, the ash softens and begins to fuse, and there is the danger that a number of pieces fusing together may plug the retort and stop the downward passage of the shale. It unfortunately happened that the softening point of the ash of the particular shale under consideration was at or near the temperature at which the process could be carried out with economical speed. In the practical working of this shale by the new system, it was evident that the process of burning away the carbon, and extracting the nitrogen, must be stopped short while there was still sufficient carbon mixed with the ash to keep it from fusing.

To determine more accurately the costs of the process for labor, fuel, and maintenance, a bench of sixteen retorts (as shown on Figs. 2 and 3) was erected in July, 1881. By the working of this bench it was ascertained that, for retorts of this size and form, a yield of 30 lb. of sulphate of ammonia per ton of shale was all that could be economically won. The general results of working these retorts were, however, so satisfactory that, in the autumn of 1881, the Oakbank Oil Company erected 288 retorts to replace an equivalent number of older retorts which had been in use previously. These retorts have continued to work satisfactorily for the past three years, last year's results having been the best yet attained. By the systems of retorting in use at Oakbank prior to 1881, the annual produce of sulphate of ammonia was 300 to 320 tons. The produce for the present year from a similar throughput of shale is 710 tons of sulphate, or a gain of 133 per cent.

Following the erection of these retorts at Oakbank, Mr. William Young carried on further experiments at Pentland Works, and succeeded in designing a form of retort which embodied the good points of the old with the most recent results of our joint experience. The principle on which these retorts are worked is identical with that already described, but, as will be seen from Figs. 4 and 5, the structure is considerably modified. Instead of cylindrical tubes, the retorts are oval, and rectangular in cross section; by this alteration the cubic content of the retorts is increased, without a corresponding increase of thickness of the mass of shale to be heated through. The quadruple hopper covering four retorts is enlarged so as to contain as much shale as the retorts themselves; the water lute sealing the bottom of the retort is replaced by a faced mouth-piece and steel door.

One of the most important alterations is the replacement of the ordinary open furnace by a gas producer of novel construction (Fig. 5). This gas producer is a vertical retort built of brick, closed by a door at the top, and provided with an exit pipe, which connects the retort with a system of mains and condensers. At its lower end the retort terminates in a closed fireplace and ashpit with regulating doors or dampers. The dross or small coal is introduced by the top door, and, resting on the firebars, fills the retort from top to bottom. The upper part of the retort, being surrounded by flues through which fire gases are led, is kept at a full red heat.

The coal at this part of the retort is distilled, and parts with gases and vapors, which pass away by the exit pipe to be cooled and condensed. As the coke passes down in the retort it is met by a current of steam which is partly decomposed, burning the carbon, and producing ammonia and water gas, which pass off along with the other volatile products. When such coke as has escaped the action of the steam reaches the firebars, it is burned into carbonic oxide by a regulated admission of air. This red-hot carbonic oxide passes off by ports at the lower end of the retort, and is burned in the flues surrounding the shale retorts. The gases from the upper part of the retort, after having been deprived of their condensable constituents, are also returned into and burned in the setting of retorts. By this system of firing, less fuel is used than by the open furnace, and the ammonia and tar recovered from the coal more than pay its first cost.

In the oil districts of Scotland, about 1,500,000 tons of shale are distilled per annum for the production of paraffin and oils. The following figures show the influence of the new process introduced in 1881. There are at present in course of erection, or in actual use, about 2,000 retorts, capable of distilling and treating under the new system 750,000 tons of shale per annum. The admitted gain of sulphate of ammonia, by the new process, is not less than 14 lb. per ton of shale, or 4,687 tons per annum, which, at £10 per ton, is equal to £46,870. But in addition to this gain of ammonia, there is also an increased yield of solid paraffin valued at about £40,000 per annum. As the costs for labor, fuel, and maintenance of the new retorts do not exceed those incurred under older systems of working, the whole of the above saving of £86,000 may be credited to the new process. By certain improvements in the process and plant, which we have been working out during the last two years, and which are now almost matured, we hope to make a further well-marked advance in economical and efficient working.

I have entered with considerable detail into the history of our researches on ammonia recovery in shale distillation, partly because the foundations of all our subsequent work were deeply laid in that manufacture, and partly because Mr. Young's and my own close connection with the industry led us to devote the greater part of our time to its development. In the years 1880 and 1881, as the application of the process opened before us, we became more and more impressed with its probable importance in the manufacture of illuminating and heating gases and in metallurgical operations. Early in 1881, through the kindness of Mr. Linton, the manager of the Edinburgh and Leith Gas Company, I obtained specimens of a number of well-known gas coals. These were analyzed by Mr. E. H. Ronalds, the nitrogen giving the following numbers:

Rosehall cannel	1·48	per cent.
Newbattle "	1·20	"
Springwell "	1·21	"
Niddrie " (1)	1·69	"
" " (2)	1·65	"
Fouldshiells "	1·37	"
Shields splint	1·20	"

In addition to the above, various of the coals in ordinary use as fuel at Oakbank were analyzed, and found to contain from 1·45 to 2·2 per cent. of nitrogen, equivalent to 147 to 232 lb. of sulphate of ammonia per ton of coal. In December, 1881, a quantity of the Niddrie cannel was distilled and treated in the retorts illustrated on Figs. 2 and 3 under conditions identical with those maintained in the treatment of the Broxburn shale. As the latter ordinarily yielded about one-half of its nitrogen as ammonia under this treatment, it was expected that the Niddrie cannel, which contained nitrogen equal to 174 lb. of sulphate of ammonia per ton, would at least yield 80 lb. to 90 lb. We were, therefore, much disappointed when it only yielded about 35 lb., or one-fifth of its total nitrogen. An analysis of the coke, after leaving the retort, showed that it still contained 1·22 per cent. of nitrogen. Taking the coke as being 60 per cent. of the original coal, then 44 per cent. of the total nitrogen of the coal had been left in it. The loss of nitrogen in the oily distillate was not determined, but must have been very high, as the weight of oil obtained was nearly twice as great as that from the Broxburn shale, and the percentage of nitrogen contained in it was somewhat higher.

Further experiments with cannel and other coals, and a careful study of all the results obtained, made it evident that the ease with which any coal or shale would part with its nitrogen under the influence of steam and a high temperature is generally inversely proportional to the percentage of fixed carbon left in the coke. A material that gives a coke containing 45 per cent. of fixed carbon would take three times as long to give up its nitrogen as one containing only 15 per cent. While it is probable that the nitrogen of coke is not chemically combined with the whole of the carbon, but only with a portion of it, and that it is by the decomposition of these carbon-hydrogen-nitrogen compounds by steam that ammonia is produced, all our practical experience goes to show that it is only by burning away the whole mass of carbon, uncombined and combined, that the whole of the nitrogen can be obtained as ammonia. We have found, and Professor Foster has independently demonstrated (*Proc. Inst. Civ. Eng.*, 1884), that steam exercises an elective action upon certain constituents of the coke, in virtue of which the coke becomes poorer and poorer in nitrogen as steaming is continued, yet in order to carry out the operation at an economical speed, and so to obtain a largely increased yield of ammonia, nearly the whole of the carbon must be removed by oxidation.

But this oxidation and removal of the fixed carbon by steam is a very slow process at any temperature at which ammonia can be kept from dissociation. The temperature at which spent shale containing only 15 per cent. of carbon can be perfectly treated in twenty-four hours is quite inadequate for the treatment in the same time of coke containing 80 or 90 per cent. of carbon. But any attempt to accelerate the operation by the use of a much higher temperature results in the loss of much of the nitrogen in the elementary condition, or it involves the use of an enormous excess of steam to protect the ammonia molecules, by conveying them rapidly from the retort.

That the process is quite practicable on a laboratory scale has been sufficiently proved by its application to the analytical determination of nitrogen by Grouven. That it is also, under certain conditions, practicable on a manufacturing scale has been definitely proved by our own experience; but, in many cases, the cost of producing and maintaining such a temperature in a bench of retorts, and of keeping the necessary plant in repair, make the process economically impossible for the ordinary run of highly carbonaceous substances. Fortunately, the difficulty had not long presented itself before the solution was suggested. As the oxidation of the excessive quantity of carbon was the great desideratum, it occurred to us to use a proportion of air with the steam to effect this. While the oxidation of carbon by steam is a reaction in which heat is absorbed, the oxidation by free oxygen produces heat. The first attempts to carry out the process with air, on a laboratory scale, were only partially successful, as it was difficult to regulate the relative amount of external and internal heating; but on applying air injectors to two of the retorts, shown in Figs. 2 and 3, no such difficulty was experienced.

The external temperature of the fireclay retorts was at once reduced to a moderate red heat, and the oxidation of the carbon proceeded quietly and regularly without interfering in any way with the ammonia production. By March, 1882, we were in a position to formulate (patent No. 1,377, of 1882) the conditions for the successful conversion of the nitrogen of carbonaceous substances into ammonia, these conditions being that the coke or residue should be burned in steam alone or in a mixture of steam and air, sufficient excess of steam being present to protect and carry off the ammonia as formed; the temperature, while sufficient for the combustion, to be as far as possible below the fusing point of the mineral ash. The added experience of three years has confirmed this definition as a sound one.

A few words of explanation of this definition may not be amiss. The process has to be clearly distinguished from several pre-existing operations. These are (1) dry distillation; (2) dry distillation in a current of steam; (3) combustion in air; (4) the form of combustion in air and steam practiced in certain forms of gas producer. The new process is not contained in either the first or second of the above, as it essentially involves the burning away of a considerable part of the carbon of the residue in steam, which was never the case in distillation with or without steam, steam in all such cases being used to prevent or retard decomposition, not to cause it. Neither is it found in the third, as steam is not used at all. Nor is it in the fourth, for although superficially the two operations seem alike, both involving the use of air and steam to oxidize the carbon, the employment of excess of steam, that is so much that a considerable portion of it passes through the red-hot coke undecomposed, introduces an altogether new set of reactions with products in quite new proportions. This is well shown by a comparison of the gas from a Wilson producer with the gas from our retorts:

	Wilson Gas.	Y. and B. Gas.
Carbonic acid	7·14	15·40
Hydrogen	12·15	34·53
Carbonic oxide	19·83	10·72
Marsh gas	3·91	4·02
Nitrogen	57·24	35·33
	99·97	100·00

(To be continued.)

THE PERFUMER'S MANUAL.

By AN EXPERIENCED MANUFACTURER.

THE object of this manual is to furnish to perfumers and chemists a selection of practical recipes, the result of years of experience and study. All of them are excellent, many of them valuable, and in careful hands, when compounded in strict accordance with the formula, are suited for specialties, and will give the maker not only a perfume that will be called for again at his own counter, but one that, if put on the market with spirit, may make a general demand from the trade; in just this way fortunes have been made.

No time or space is taken up with the history or poetry of the profession, ancient and honorable as it is; and all the articles used are such as may be found in any wide-awake drug store, or can be obtained in large or small quantities of the importers in our large cities.

Some of the materials offered to perfumers are not in these recipes, for the reason that all are not requisite, and too many tend to confuse. The catalogues of the importers give the whole variety, and it is well to try cautiously new articles offered, so as to learn their true value.

Manipulation of Floral Pomades.—The floral pomades can be bought of importers in packages of from 2 lb. to 20 lb. The most useful odors are orange flower, rose, cassie, violet, jessamine, and tuberose. Some experts question the genuineness of the violet pomade, and say that it is made up with orris, etc.

Manipulation.—Take, for example, 1 lb. pomade orange flower. Put the pomade in a gallon vessel with close cover; place in a water-bath, and melt; when melted, pour in, while stirring, 4 pints alcohol; keep at a moderate temperature during the day, stirring occasionally; let it stand all night; next day pour off the spirit through a muslin filter, and you have extract orange flower. If carefully done, nearly all the spirit can be secured. The extract thus obtained must then be chilled, by an outward application of ice, down to 32°, and then again filtered through a paper filter. This freezing process and last filtration is necessary to keep the extract from showing particles of pomade in cold weather; allowing 4 oz. for waste, you have 3¾ pints. The perfume remaining in the pomade can be further extracted by adding another pint of alcohol, and proceeding as at first, if so desired. When this is finished, pour the two extracts thus obtained together, making one quantity of equal strength, and then calculate the cost. Always mark the cost per pint or gallon on every extract, infusion, etc.; this saves much time and labor hunting up the price when wanted for use. Some perfumers want two weeks to make the infusion.

Bouquet extracts from pomades alone are very fine, but not as permanent as those made by the more enduring power of seeds, bark, roots, gums, etc., and those of animal origin, as musk, ambergris, and civet, whose tenacity of odor when properly subdued is wonderful when added to the floral extracts.

Musk ought to be bought by the caddy, or several pods at a time selected to make a good average; if bought right, nothing good in perfumery is cheaper.

Take 1 oz. of musk in pod; cut it in pieces; put into a gallon bottle with 8 oz. of water; let it stand for 6 hours to soften; then fill up the bottle with alcohol;

after remaining for seven days, shaking frequently in the interval; decant carefully; measure the quantity obtained; calculate the cost, and mark it on the bottle.

Orris.—Buy only the fragrant Florentine orris; have it crushed to the size of coarse meal; powdered orris is not desirable. Put two pounds crushed orris in a gallon bottle; cover with water to swell the root; after standing six hours, not more, fill up the bottle with 95 per cent. alcohol. It will be ready for use in about one week. Extract of orris is always used in violet perfumes, and is good in many bouquets and colognes.

Deer Tongue.—This is a leaf that is gathered in Florida, and has great similarity to Tonka and not one-tenth its cost. Put 1 lb. in a gallon bottle, fill up with alcohol only, as it contains a fixed oil which refuses water.

Vanilla.—For perfumer's use the short vanilla bean pays the best; they yield as much per pound as the long, and are much cheaper. Put 1 lb. vanilla beans cut fine in a gallon bottle; just cover with water, and let it stand for six hours, then fill up the bottle with alcohol; digest for a week, shaking several times a day; then decant, and calculate the cost; after this put on another gallon of alcohol, at 80 per cent., to secure all the odor that is left in the bean.

Tonka.—Crush 1 lb. Tonka beans in an *iron mortar*; put into a gallon bottle with one pint of water to swell them; after a few hours fill up the bottle with alcohol, and treat the same as vanilla.

Civet.—Civet has been considered one of the most difficult of materials to treat satisfactorily. I have always been successful by using the following method:

Take one ounce civet and four ounces powdered orris; mix well together in a marble mortar, with the aid of a few ounces of water, until the whole is a fine paste. Put into a gallon bottle, and fill the bottle with 95 per cent. alcohol; shake frequently. Civet is very diffusive, and should be used with care; it strengthens musk, and is used in many bouquet odors. Mark the cost per ounce on the bottle.

Benzoin.—Take 1 lb. of the gum benzoin; crush in an iron mortar; put in a bottle with one gallon 95 per cent. alcohol; shake occasionally; it will be ready for use in one week. When the extract has all been used, you can put say one-half pound more of crushed gum benzoin to that left in the bottle; fill up the bottle again with alcohol, and you have extract benzoin of good strength.

Ambergris.—Ambergris, a supposed product of the sperm whale, is one of the most costly materials used in perfumery, and can only be used in extracts that command the best prices. Many perfumers of good reputation, and who have made money, say they seldom use it, while others consider it indispensable in combinations; if desired to experiment, get a small quantity, dissolve in warm alcohol to make solution, and use with care in proportion to the price of the extract to be made.

First Quality Extracts.

Marie Stuart, No. 1.

Extract musk	4	oz.
" civet	4	"
" benzoin	4	"
" orange flower	16	"
" oil of rose, Kissanlik	60	minims.
Oil bergamot	60	"
Extract tonka	4	oz.
Alcohol	1	gallon.
Water	1	pint.

Jockey Club, No. 1.

Extract musk	1½	pints.
" civet	2	oz.
" benzoin	1½	"
" orange flower	4	"
" otto rose, Kissanlik	2	drachm.
Alcohol	1	gallon.
Water	½	pint.

Note.—The water should not be put in until the oils are all cut or dissolved by the alcohol, and after that the extract should have time, say one night, so as to digest fully. It must always be kept in mind that the finest perfumes are really costly, and you should not expect to make for $1 what costs another perfumer $1.50.

Moss Rose, No. 1.

Extract rose from pomade	4	pints.
Turkish rose	½	oz.
Otto rose, Kissanlik	½	drachm.
Extract musk	1	oz.
" civet	½	"
" benzoin	½	"
Alcohol	½	gallon.
Water	4	oz.

White Rose, No. 1.

Otto rose, Kissanlik	2	drachms.
Extract orange flower	2	oz.
" civet	1	"
" benzoin	1	"
" vanilla	½	"
Turkish rose	1	drachm.
Alcohol	2½	quarts.
Water	4	oz.

Violet, No. 1.

Extract violet from pomade	4	pints.
" orris	4	"
" orange flower	2	oz.
" cassie	2	"
" ylang ylang	1	drachm.
Otto rose, Kissanlik	½	"
Civet	1	oz.
Bergamot	1	drachm.
Water	4	oz.

Bouquet Fedora, No. 1.

Otto rose, Kissanlik	½	drachm.
Turkish geranium	¼	oz.
Oil patchouly	½	drachm.
Extract tonka	3	oz.
" musk	2	oz.
Orange flower	3	"
Extract vanilla	½	"
" civet	½	"
Alcohol	2½	pints.

Jessamine, No. 1.

Extract jessamine from pomade	8	pints.
Oil lemon	½	oz.
" bergamot	½	"

Tuberose, No. 1.

Extract tuberose from pomade	8	pints.
True cinnamon	8	minims.
Oil bergamot	½	oz.

New Mown Hay, No. 1.

Oil geranium from leaf	2	drachms.
Turkish geranium	2	"
Extract white rose	1	quart.
" orange flower	1	pint.
Tonka extract	8	oz.
Alcohol	2	quarts.
Extract vanilla	4	oz.
Water	4	"
Extract musk	4	"

For new names for bouquet odors, take names of persons or places as desired.

Magnolia, No. 1.

Otto rose	1	drachm.
Oil Turkish geranium	1	"
Extract tonka	4	oz.
" civet	1	"
" musk	3	"
" orange flower	6	"
" vanilla	6	"
Alcohol	½	gallon.
Water	4	oz.

Ylang Ylang, No. 1.

Oil ylang ylang	2	drachms.
Extract orange flower	2	oz.
" civet	1	"
" benzoin	1	"
" vanilla	½	"
Oil Turkish rose	1	drachm.
Alcohol	2½	quarts.
Water	4	oz.

Rose Sandal, No. 1.

Oil sandal	2	oz.
Alcohol	½	gallon.
White rose extract	½	"

Heliotrope, No. 1.

Extract orange flower	8	oz.
" white rose	1	quart.
" vanilla	½	pint.
" benzoin	1	oz.
" civet	1	"
Alcohol	1	pint.
Oil bitter almonds	3	minims.
Water	2	oz.

Note.—If you will get the *flower* heliotrope, you will notice a slight odor of bitter almonds. Put into the extract only the amount required to *imitate* that.

Patchouly, No. 1.

Oil patchouly	3	oz.
Extract benzoin	2	"
" civet	2	"
" orange flower	4	"
Alcohol	1	gallon.
Water	2	oz.

Ess. Bouquet, No. 1.

Oil leaf geranium	1	oz
" Turkish geranium	⅓	"
Otto rose	1	drachm.
Extract musk	6	oz.
" tonka	6	"
" orange flower	5	"
" vanilla	2	"
" civet	1	"
Alcohol	1	gallon.
Water	4	oz.

Bouquet de Caroline, No. 1.

Add to recipe for Ess. Bouquet 1 pint extract neroli, costing same sum.

Millefleur, No. 1.

Add to Bouquet de Caroline:

Extract orange flower	1	pint.
" civet	1	oz.
" benzoin	1	"

Geranium, No. 1.

Oil geranium leaf	2	oz.
" Turkish rose	2	"
" bergamot	1	"
Extract orange flower	5	"
" civet	1	"
Alcohol	1	gallon.
Aqua	8	oz.

Frangipanni, No. 1.

Oil fine lavender	½	oz.
Oil geranium leaf	½	oz.
" Turkish geranium	½	"
Otto rose	1	drachm.
Extract musk	6	oz.
" tonka	6	"
" sandal wood	1	pint.
" vanilla	2	oz.
" civet	1	"
Alcohol	1	gallon.
Water	8	oz.
Extract orange flower	5	"

Sweet Pink, No. 1.

Oil ylang ylang	1	drachm.
" bergamot	2	"
Extract benzoin	2	"
Civet	2	"
Extract rose from pomade	8	oz.
Alcohol	1½	quarts.

The cost of these formulas varies for the No. 1 extracts from $1.50 to 75 cents per pint. No. 2 are 40 cents per pint at present price of alcohol and other material.

Second Quality Extracts.

The trade always expect goods of a second grade, which may be really good, but not so costly. Our market is usually supplied with two qualities of manufacture. In perfumery it happens that some of the most costly essential oils are not agreeable to some persons unless in diluted proportions, hence the propriety of our second grade. The amount of water is also increased in No. 2 extracts.

Magnolia, No. 2.

Oil bergamot	2	oz.
Extract vanilla	8	"
" tonka	2	"
" civet	1	"
" benzoin	1	"
Alcohol	2	gallons.
Water	3	pints.

Night Blooming Cereus, No. 2.

Extract vanilla	8	oz.
" civet	2	"
" benzoin	2	"
Oil bergamot	2	"
Alcohol	2	gallons.
Water	3	pints.

Marie Stuart, No. 2.

To recipe for Night Blooming Cereus:

Extract tonka	4	oz.

Patchouly, No. 2.

Oil patchouly	1	oz.
Extract benzoin	1	"
" civet	1	"
Alcohol	1	gallon.
Water	3	pints.

Heliotrope, No. 2.

Oil bergamot	1	oz.
Extract vanilla	½	pint.
" civet	½	oz.
" benzoin	½	"
Alcohol	1	gallon.
Extract orris	1	pint.
Oil bitter almonds	5	drops.
Water	3	pints.

Geranium, No. 2.

Oil geranium leaf	1	oz.
" Turkish geranium	1	"
" bergamot	1	"
Extract benzoin	2	"
" vanilla	2	"
Alcohol	2	gallons.
Water	3	pints.

Sweet Brier, No. 2.

Add to Geranium, No. 2:

Verbena extract, No. 1	1	pint.

White Rose, No. 2.

Oil Turkish geranium	2	oz.
" bergamot	2	"
Extract benzoin	3	"
" vanilla	2	"
Alcohol	2	gallons.
Water	3	pints.

Verbena, No. 2.

Oil lemon grass	3	oz.
" bergamot	2	"
Extract civet	1	"
" benzoin	2	"
Alcohol	2	gallons.
Water	3	pints.

Jockey Club, No. 2.

Oil bergamot	2	oz.
" lavender, fine	½	"
Extract civet	2	"
" benzoin	2	"
" musk	1	pint.
Alcohol	2	gallons.
Water	3	pints.

Violet, No. 2

No. 1 ylang ylang	1	pint.
Extract cassie from pomade	8	oz.
" civet	2	"
" vanilla	4	"
" orris	1	pint.
Alcohol	2	gallons.
Water	3	pints.

Farina Cologne.

Oil lemon	2½	oz.
" bergamot	2¼	"
" lavender, fine	½	"
" neroli	2	drachms.
Extract orange flower	4	oz.
" musk, best	4	"
" civet	½	"
Alcohol	3	gallons.
Water	3	pints.
Extract benzoin	1	oz.

Fragrant Cologne.

Oil bergamot	3	oz.
" lemon	1	"
" lavender, fine	¼	"
" cloves	¼	"
" sandal wood	¼	"
Alcohol	2	gallons.
Water	3	pints.

Florida Water.

Oil bergamot	2	oz.
" lavender, fine	1	"
" cloves	¼	"
Extract civet	1	"
Oil pimento	¼	"
Alcohol	2	gallons.
Water	4	pints.

West End Cologne.

Oil bergamot	2	oz.
" lavender, fine	2	"
" cloves	½	"
" mace	½	"
Extract civet	1	"
" benzoin	1	"
" vanilla	1	"
Alcohol	2	gallons.
Water	4	pints.

Bouquet Ristori.

Oil rose, Kissanlik	½	oz.
" sandal wood	½	"
Extract tonka	1	pint.
Alcohol	2	gallons.
Water	4	pints.

Bay Rum.

Bay oil	1	oz.
Oil pimento	¼	"
Alcohol	2	gallons.
Water	4	pints.

Vegetable Tonic Tooth Wash.

Soap bark, ground	2 lb.
Water	1 gallon.
Add Honey	4 oz.

Simmer in warm water several hours; let it stand over night; strain through muslin. To the fluid product add an equal amount of alcohol in which has been dissolved—

Gum myrrh	1 oz.
Oil tea berry	1 "

Color with red sanders, digest one week, and filter. This is about the best tooth wash that can be made.

MATERIALS FOR TOILET POWDER.—English china clay, American Paris white, English cliff stone, Paris white, prepared chalk, dropped chalk, French talc.

Complexion Powder. Violet.

Best starch	25 lb.
Terra alba	25 "
Talc (without *mica*)	25 "
French chalk	25 "
Pulverized orris	10 "

Grind well together with 8 oz. Turkish geranium oil, 2 oz. oil of citronella. Then sift through *fine wire sieve.*

For flesh tint: Add to 2 lb. of the Violet Powder 8 oz. carmine. Triturate carefully and completely; when thoroughly ground, add Violet Powder until the desired color is obtained.

GUICHARD'S THERMOMETER.

MESSRS. GUICHARD & CO. are constructing a thermometer, the principle of which is the same as that of

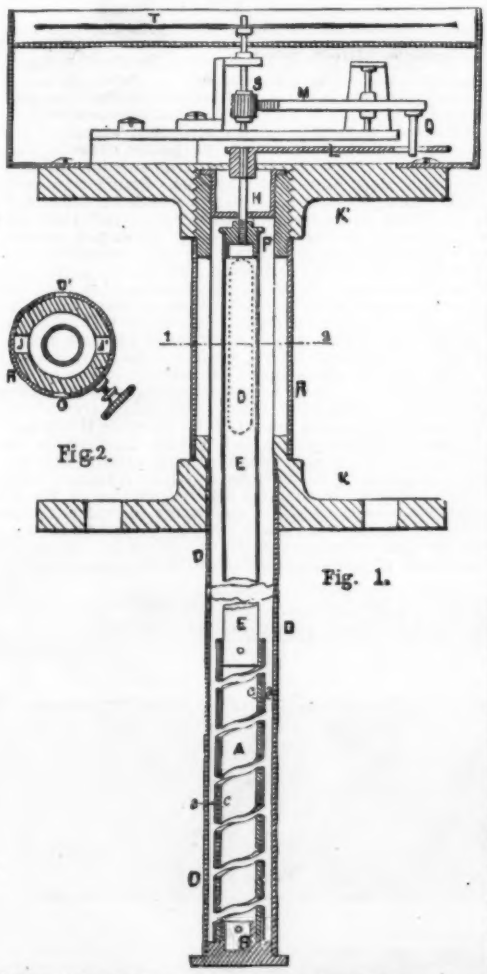


Fig. 2.

Fig. 1.

Breguet's and all metallic thermometers in general, but which presents a certain number of peculiar arrangements that make a new apparatus of it.

It consists, as in all other apparatus of the kind, of a spiral formed of two metals soldered together, the differences in torsion, due to changes in the temperature, being shown by a needle that moves over a horizontal or vertical dial. Fig. 1 represents a section of an apparatus with a horizontal dial, and Fig. 2 shows a section through the line 1–2 of Fig. 1.

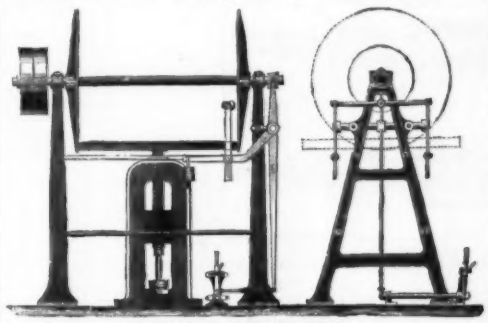
The spiral, A, consists of two strips soldered together, one of which, *c*, of copper, forms the internal surface, and the other, *a*, of steel, the external surface. This spring, A, is fixed by one of its extremities to a cap, B, and by the other to a tube, E. The whole is surrounded by a tube, D, which terminates in the flange, K, of a cylinder, R, whose other flange, K', supports the box which contains the movement, the dial, and the needle. The cylinder, R, is provided with two longitudinal apertures, O and O', which may at will be brought opposite two corresponding apertures, J and J', in the inner tube. In this case, the spring, A, is put in more direct communication with the surrounding medium, and takes its temperature more quickly. The variations of the spring are transmitted to the needle as follows: The tube, E, terminates in a cap, P, to which is screwed the axis of a lever, L, which thus participates in all the spring's motions. This lever in turn actuates the needle through the intermedium of the pin, Q, of the sector, M, and of the pinion, S, keyed to the needle's axis. The motions of the needle are thus amplified, so that the apparatus shows the minutest movements of the spring, corresponding to very slight variations in the temperature.

In short, the apparatus is characterized by great sensitiveness of the spiral strip of metal and by the special arrangement for amplifying the needle's motions, thus giving the indications extreme accuracy. —*Chronique Industrielle.*

LEAD-CASE PRESS.

THE manufacture of thin lead cases in which perfumery is contained has attained such dimensions as to call for the use of machinery.

These cases are simply thin cylindrical shells with



LEAD CASE PRESS.

screwed capsules, and are used also for many other purposes, such as, for instance, pigments for artists and decorative work generally.

The machine consists of a fly screw press, the fly of which is driven in either direction by the action of the friction disks on the horizontal shaft carrying the belt pulleys. The shaft is capable of an endwise motion, which is imparted to it by means of the hand lever at the foot of the standards, the weighted lever serving to keep the right-hand disk in action against the fly unless released for raising the die by hand with the left disk in contact.

This arrangement allows of a rapid motion being quickly imparted to the heavy fly-wheel. Within the die is placed a flat disk of lead. The plunger which enters the die has a clearance all round equal to the intended thickness of the cases to be made. It is evident, then, as the fly revolves and the plunger is screwed down until it comes in contact with the lead disk that something must give way, for the motion of the heavy fly cannot be instantaneously arrested. The most likely to give way is apparently the screw or the plunger, and probably they would do so but for the one safety valve which is left, and that is the narrow space of freedom round the plunger.

Into this narrow space the lead washer escapes under the enormous pressure to which it is subjected by the fly. In this way cases as much as 12 inches long can be made, the plastic metal flowing readily through the narrow annulus, and the capsule end of the case being formed by a suitable recess at the bottom of the die. This end only remains to be screwed and pierced and the case is ready for filling, after which the open end is folded over and closed in the usual manner.—*Mech. World.*

ACCIDENT TO THE GAS-HOLDERS OF THE ST. LOUIS GAS COMPANY.

MR. J. B. JOHNSON, member of the Engineers' Club of St. Louis, read a paper some time since before that body on the above subject. We take a few extracts from it:

"There were twelve cast-iron, hollow, cylindrical columns, each 75 feet high, supporting a holder 140 feet in diameter. The whole was erected in 1857, and failed by the southern columns breaking outward on the night of December 11, 1884. Snow had fallen during the day and evening, and this had the tendency to drift over on the south side.

"The columns were cast in solid sections about nine feet in length, with flanges turned inward, being bolted together on the inside through the flanges. They were three feet in diameter at bottom and two feet in diameter at top. The metal of shell would average about one-half inch in thickness. The columns on the north side broke off near the top, while those on the south side broke in the middle and at bottom.

"The failure was caused by the upper, or inner, section of the holder getting pinched or caught while settling down inside the lower and outer section. It was caught in this manner on the north side, when the top was some 22 feet above ground. The two sections are each 35 feet high, so the upper section had already moved down through the lower one a distance of some 13 feet. *There were no guide or friction rollers on the inside to prevent this pinching action.* Had there been, such an accident could never have happened.

"The two broken columns on the south side fell away, the middle falling outward and the tops inward. The top trussing, connecting the columns, fell upon the top of the holders and broke two holes a foot or two in diameter. The gas at once escaped from there and took fire, probably from a friction spark. The tank, being relieved of the inward pressure, settled away toward the south, until it pulled the remainder of the columns after it, when the tops of the northern columns, with the trussing here, falling upon the top of the holder, it gave way generally, and the gas, escaping in solid mass, was burned as though it came from a burner. There was a stiff breeze blowing from the north, and had been all day. The snow had a tendency to drift somewhat over on the south side of the holder, as the top was spherical. The breeze and unsymmetrical snow-load both tended to cause the lower edge of the north side to hug the inner face of the outer shell in settling away. There being no rollers to keep it off, it got caught on rivet-heads, or in some other way, and the more the rest of the tank settled the tighter this was held, and so failure became inevitable."

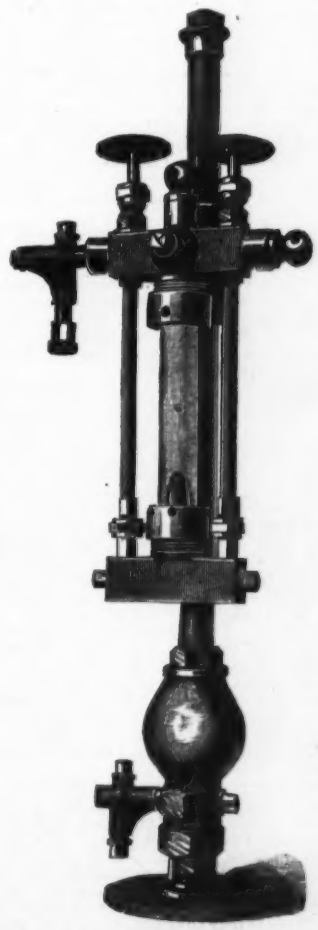
SIGHT FEED LUBRICATOR.

OUR illustration represents a sight feed lubricator, by Mr. Sumner, Brook Street, Oldham, which presents points of interest. The apparatus consists of three tubes connected at their upper and lower ends by cross pieces. The two outer tubes can be closed at the top by suitable valves, the spindles of which are seen in the engraving. Immediately above the middle tube, which is the sight tube, there is placed a three-way cock communicating with the sight tube and the feed tube connected to the cylinder. The latter tube passes down the center of the stand, and terminates with a bend in the globular portion of the stand; its end is protected by a back pressure valve. There is also a back pressure valve at the lower end of the sight tube, which allows the oil to enter but prevents the water from finding its way out.

The oil is fed to the engine under pressure by means of a pump actuated by a pawl or detent; any speed of discharge can be attained by simply moving the point of attachment of the reciprocating part of the engine nearer to or further from the fulcrum of the arm carrying the pawl.

The oil enters the lubricator at the upper left hand corner, passes down the vertical tube, and then up through the sight tube; the right side tube in the mean time is closed, and in fact is nothing more than an additional tube to be used in case of emergency, the apparatus being complete without it. When once the oil passes the back-pressure valve, and enters the sight tube, it cannot return, and simply rises through the water, thence down the feed tube in the interior of the stand, and out through the connection shown at the bottom to the engine. The instrument may stand any distance from the cylinder, and so all the parts can be kept perfectly cool. If required at any time, the oil can be fed direct to the cylinder by simply closing the screw-down valve and turning the three-way cock, so that no time is lost should the glass at any time break.

We may also notice that the upright stand can be



SIGHT FEED LUBRICATOR.

used in the same way as an ordinary tallow cup. The outlet at the lower extremity being closed by a back pressure valve, the cap at the top of the stand may be unscrewed and the lubricant poured in, whence it may be led to the parts to be lubricated. The top of this stand is fitted with an air valve opening inward, the function of which is to admit air should there be any tendency for a vacuum to form in the interior by the condensation of steam; the water is thus never drawn out of the sight tube.

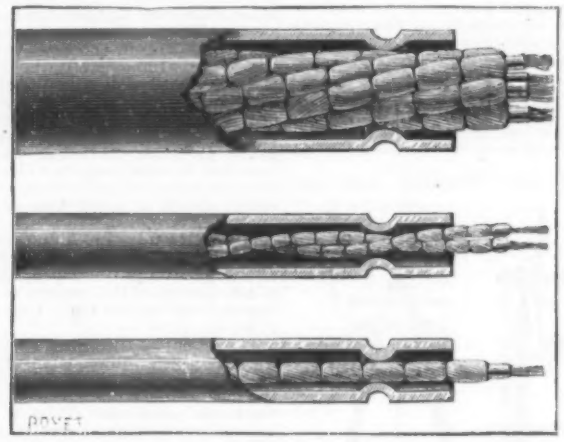
Suitable provision has been made for cleaning all the parts, and the fitting will, we do not doubt, be found to answer its purpose satisfactorily.—*Mech. World.*

NEW SYSTEM OF TELEGRAPH AND TELEPHONE CONDUCTORS.

The question of telegraph and telephone lines is at present one of prime importance. In the present note we desire to make known a new and important progress that has been made in their manufacture through the invention of a system which, we believe, is destined to have a grand future.

Electrical conductors, according as they are suspended in the open air or covered with an insulating envelope that allows them to be placed in subterranean conduits or immersed in the waters of rivers, lakes, or oceans, are designated as "aerial," "subterranean," or "submarine" lines.

Under experimental conditions, the aerial line is the most perfect of all. The deflection of the needle of a galvanometer at one extremity of an aerial line is followed by that of the needle of a galvanometer at the other end within a minute fraction of time; the passage of electricity through a well insulated line of this kind, then, is nearly instantaneous. In practice, that is to say, when called upon to do regular work, aerial lines do not always give the results which they promise. Atmospheric and material influences, such as fogs, rain, hoar frost, ice storms, and the breaking of poles, are accidents that cause such trouble in telegraphic transmission that an endeavor has been made to remedy it by laying subterranean lines.



HERRMANN'S TELEGRAPH AND TELEPHONE CABLES. (Actual size.)

By reason of this very construction, subterranean lines have none of the inconveniences of aerial ones. But, in order to insulate the conductors, it has been found necessary to envelop each of them as hermetically as possible with insulating materials. From this there have resulted various annoying phenomena, such as induction, electrostatic charging, etc. These inconveniences have so great an influence upon the transmission of electric currents that they have kept electrical engineers constantly busy with researches or methods of overcoming them. The most ingenious artifices have been employed, but they do not seem, up to the present, to have given their authors the results that they hoped for.

The defects of subterranean lines—induction and the electrostatic charge—are likewise found in submarine ones.

The new system which we are about to make known requires tools of special construction, but it gives results of high importance, which will be submitted to the Academy of Sciences at an approaching meeting. It is the invention of one of our most skillful engineers, Mr. Adolphe Fortin Herrmann.

The principle of the system is the application of the qualities of aerial and subterranean lines. The aerial line type permits of the most rapid transmission possible through the air, which latter is the best insulator and best dielectric. Starting from this point, Mr. Herrmann sought a means of preserving this dielectric and of shielding it against atmospheric influences. The problem to be solved, then, was to construct a line which should be at the same time an aerial and a subterranean one, that is to say, be in air and yet be protected from all those causes that interfere with aerial lines. Such a result has been obtained by means of the arrangement shown in the accompanying cut. The conductor is introduced into small tubes of wood that touch each other. Thus prepared, it is introduced into a leaden pipe and thus forms the line. It can be manufactured quite cheaply with the aid of the very ingenious machine that Mr. Herrmann has devised.

This mode of construction allows the electric line to be placed indifferently in the water, earth, or sewer, or the air, or under the influence of a high temperature limited only by the fusing point of the lead that forms the envelope.

In the earth or water these conductors are not submitted to atmospheric influences, but preserve their valuable dielectric—air. Induction and the electrostatic charge do not exist in them. Whatever be the velocity with which transmission is done, the conductor remains free after every emission. We trust that this new system will prove a powerful aid to telegraphic transmission, and the more so since at the present time there is fear that the supply of gutta percha may give out.—*La Nature.*

SYNCHRONISM.*

By Prof. Edwin J. Houston.

Among the many practical problems whose solution has long been sought for, but sought for in vain, until very recently, is the problem of obtaining approximately absolute synchronism.

A pendulum completes its to-and-fro motion, or oscillation, in a given time, that is, independent of the distance through which it swings, or, in other words, independent of the amplitude of its oscillation; the time required to make one complete oscillation being exactly the same as that required to make any subsequent oscillation. This fact is expressed when we say that the oscillations of a pendulum are isochronous.

When we include the idea of any one event happening in exactly the same time as that required for another event to happen, we express this fact correctly by saying that the movements of the two are synchronous. That is to say, the two not only start together, but complete all parts of their motions in the same time.

In order to render the preceding clearer, let us suppose that two tuning forks be started in vibration. Either fork will continue to make isochronous vibrations, if the time required by such fork to complete any single vibrations is the same as that required to complete any subsequent vibration. While the vibrations of either fork may be isochronous, it does not follow that the vibrations of the two forks are synchronous.

Either of the two forks may be isochronous in its motions, although one of the forks may make 256 vibrations per second while the other makes 512 vibrations per second. Either of the forks is isochronous, because it requires the same interval of time to complete any single to-and-fro-motion; but the two forks are not synchronous, since one of them makes 256 vibrations per second while the other makes 512 vibrations. In order that they may be synchronous, they must each make the same number of vibrations in the same time.

The modern idea of synchronism includes the additional notion that the two bodies must not only move through the same distance in the same time, but also that their motions during the entire time must be exactly similar, that is to say, that they must be synchronous at all points during their movements.

Let us suppose, for example, that two pendulums be started at exactly the same time, and be permitted to swing for, say, one minute. It does not at all follow that, because they make the same number of oscillations during that time, their oscillations have been necessarily synchronous throughout the entire time of their movements, that is, throughout the entire minute; since, in accordance with the definition of synchronism we have above given, it is not only necessary that the two bodies shall have moved through an equal distance, or, in other words, shall have started and stopped at the same time, but that they shall have been synchronous in their movements throughout all parts of the entire number of vibrations made.

Many attempts have been made to attain synchronism, but up to within comparatively recent date it would seem that these attempts have been unsuccessful in obtaining the synchronism to which reference have just been made, that is, the synchronous movement, for an indefinite period of time, of free moving bodies mechanically independent. For example, a ratchet wheel and cog wheel, controlled by pawls, star wheels, friction or other mechanical devices, may be approximately synchronous in their movements, but with such movements I do not propose to treat, since they could not well be otherwise than approximately synchronous, and are not involved in a proper understanding of the term.

For example, the House Printing Telegraph, Hughes' Printing Telegraph, Calahan's Stock Printing Telegraph, Edison's Chemical Stock Printing Telegraph, Meyer's Multiplex Telegraph, Baudot's System of Telegraphy, Casselli's and Bonnelli's Autographic or Facsimile Telegraph, and Edison's Autographic Telegraph, are all operated by mechanically synchronized movements, which are brought into unison at given times by certain mechanical devices electrically controlled, which bring them to a full or partial stop by certain mechanical impediments, frictional or otherwise, to their free motion; and these corrections, being in all cases prearranged, are made use of whether the movement of the machine requires them or not.

Such movements, however, are not comprised in the idea of synchronism as it has been above defined, nor are they worthy the designation of synchronous movements, since their movements are never free or independent of mechanical appliances. They merely afford instances where different apparatus are maintained in a somewhat approximate synchronism for a very brief interval, when they are stopped, brought into unison, and again started.

A considerable stride in the direction of true synchronism was made by Prof. Paul La Cour, of Copenhagen, whose genius has created the phonic wheel, a contrivance by means of which a rapidly interrupted circuit in an electro-magnet keeps in even rotation an armature wheel, the impulses of the magnet being made effective by increments so fine on the armature wheel that a uniform movement, hardly attainable by any other known device, is produced.

In strong contrast with the previously mentioned efforts toward synchronism, we have to-day the practically perfect synchronism of Mr. Delany, who, with marvelous ingenuity, has succeeded in obtaining and maintaining synchronism in the highest and best sense of the term.

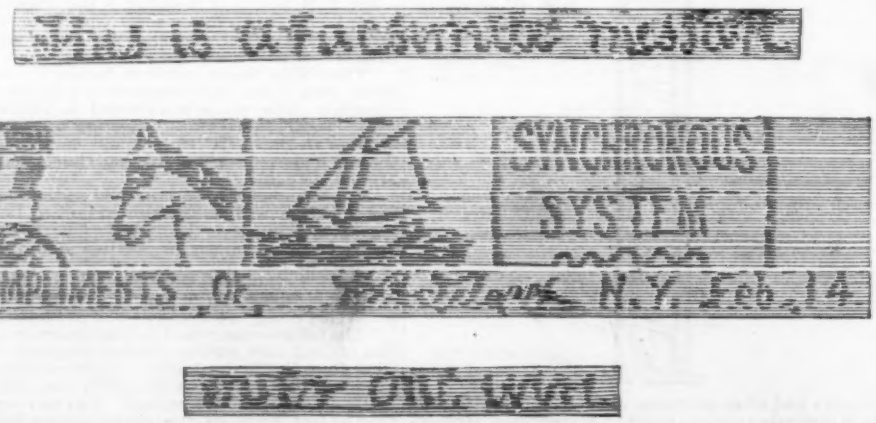
I will be better understood when I call your attention to the fact that he has succeeded in keeping two bodies, separated by hundreds of miles, in synchronous rotation for periods of upward of seventy hours, without variation during that time of the $\frac{1}{1000}$ part of a second. This is equivalent to two entirely independent bodies separated from each other by hundreds of miles starting together and passing through a distance of nearly one hundred miles without varying the $\frac{1}{100}$ part of an inch in that entire distance, or the $\frac{1}{1000}$ of a second during that entire time.

The period of seventy hours I have mentioned has no significance, so far as the limit of time is concerned, since these movements can be maintained for weeks, or months, or even for an indefinite period, with a like degree of accuracy; it being only necessary to keep the voltaic batteries used in this system in working order.

Mr. Delany has chosen for his system the phonic wheel of La Cour as affording the movement the best suited for regulation by his synchronizing device.

I will pass over the results he has already obtained in the shape of multiplex telegraphy, which, as you are probably aware, has been in successful practical operation under his system for some months past. In this system, circuits ranging in number from six to seventy-two, according to their capacity, have been obtained over a single wire, admitting of the transmission of from six to seventy-two separate messages at practically the same time, either all in one direction, or any portion of the whole number in opposite directions. These circuits so obtained may be adapted to the Morse system or to the printing system, the Morse system being applicable up to twelve circuits at the ordinary rates of transmission; the speed of any number of circuits being dependent on the number of connections that any particular instrument gets with the line in a given time.

The operation of the Morse system by the synchronous method involves a feature that has probably never been explained, and to it I will therefore call your particular attention. If we consider that for one complete rotation of the synchronized distributer, which constitutes one end of the line, the line passes over 72 contacts, which may be used for the transmission of messages, and that, under the sextuplex organization, each of the six operators' instruments would be connected to twelve of these contacts in the circle, and that the distributer rotates at the rate of $2\frac{5}{6}$ times per second, we will find that each of the six operator's instruments would be connected to the lines 12 times for each complete rotation, or 34 times per second, and that all these operators have been put in connection with the line, and with their correspondents at the distant ends, through the synchronized distributer at that point, 34 times in a second. Now, while one operator is making the shortest character or letter in the Morse alphabet, which is the letter *e*, consisting as it does of a single dot, let us see what takes place while this single dot is being transmitted. Let us imagine that when the first operator touches his key, and depresses it for the shortest interval of time that he is capable of holding it depressed, the distributer with its trailing finger, which is the end of the line, passes over one of the 12 segments connected to this operator's instrument, and transmits to the other end a portion of this single dot, but does not complete it until the other five operators have been placed in connection with the line, and the second or third segment of the first operator's circuit has been touched by the trailing finger, when the single dot representing the letter *e* is completed. Thus one dot is made up of two, three, or more shorter impulses, which manifest themselves on the polarized relay at the distant end, as one short signal, notwithstanding that portions of letters or characters have been transmitted by five other operators between the time of the beginning and the completion of this single dot. This is an irrefutable evidence of a synchronism that has never before been more than contemplated as but a remote possibility.



* A paper read before the American Institute of Electrical Engineers, at Philadelphia, October, 1884.

The operation of the printing instrument by this system is another illustration of the degree of perfection of Mr. Delany's synchronism that is hardly less striking than the foregoing; since if seventy-two printing instruments are used, each instrument must be dependent on a single segment for its messages, and an instrument at each end of the line being connected to a single segment correspondingly located, the distributer must connect the line with those single segments at precisely the same instant, otherwise no impulse for the indication of a letter on the type wheel will be received. Theoretically, it might be supposed that the transmission of a signal, say from Philadelphia to New York, by an instrument connected to a single segment would not necessarily require that the trailing finger in the New York instrument should be on the corresponding single segment at the time that the signal was sent into the line at the Philadelphia end. Or, that the trailing finger on the New York instrument might be one segment behind the segment corresponding to the segment on which the signal was sent into the line at Philadelphia, and that still that the signal could be received on the corresponding segment in the New York instrument, since the time required for that signal to pass and manifest itself in New York would be sufficient to allow the New York instrument to reach the segment corresponding to the one from which the signal was sent into the line from Philadelphia. The fact that it takes time for the transmission of signals according to the distance and other conditions not necessary to discuss here, no one will dispute; but that this time admits of variation of movement or departure from synchronism in Mr. Delany's machine is disproved by the machines themselves; for, if another instrument be connected to the next adjoining single segment in each machine, and a signal be sent from New York to Philadelphia immediately after, or within about the $\frac{1}{144}$ part of a second afterward, the signal from New York is received in Philadelphia as perfectly as that from Philadelphia was received in New York, thus showing conclusively that the conditions of variation before referred to could not have existed, since otherwise no signals could be received from New York or Philadelphia, over the second segment, as the Philadelphia instruments would have left the segment before the signal could have been completed on the segment in the New York machine and transmitted to Philadelphia.

Probably the most extraordinary proof of practically absolute synchronism was demonstrated by the experiment recently made by Mr. Delany over the line between Boston and Providence, whereby a single dot was transmitted from Boston to Providence and automatically repeated back and forth over the same wire at practically the same instant of time, traveling over different circuits in rotation backward and forward for the duration of five minutes, during which time it traveled four hundred and fifty thousand miles, this time, of course, being almost wholly represented by the movement of the armatures of the instruments. When we consider, however, the conditions involved in the transmission of a single dot, as in the case of the letter *e*, already referred to, the extent of perfection of the synchronism obtained will be understood.

Before concluding, I desire to call your attention to some contemplated applications of the wonderfully complete synchronism of Mr. Delany which he has conveyed to me. Among some of these may be mentioned facsimile transmission, or the reproduction of signs, characters, or hieroglyphics. For instance, a facsimile copy of a dispatch, or drawing of a map, or a pen portrait of an individual may be transmitted to any distant point. The prime condition necessary being synchronism, the time is probably not far distant when the civil authorities can render the identification of criminals almost certain by having their portraits in the hands of an officer on the arrival of the train upon which the criminal has fled. Or, a newspaper in these days of enterprising journalism may have transmitted for publication a sketch of a great public disaster or of any other event calling for illustration.

In conclusion, permit me to say that the invention by Mr. Delany of practically complete synchronism would appear to go no little way toward the solution of a problem that stares practical men so squarely in the face. I allude to the problem as to what shall be done with the electric conductors that are strung over the houses and through the streets of our large cities. Whether these wires are to be placed underground or are to continue overhead is a problem which in my opinion is as yet far from being solved. The increased capacity which Mr. Delany has obtained for every wire will, it is clear, greatly decrease the number of wires required for actual use, and this makes the problem referred to somewhat easier of solution.

CHEMICAL CHANGES IN THEIR RELATION TO MICRO-ORGANISMS.

AT a recent meeting of the Chemical Society, London, a lecture was delivered "On Chemical Changes in their Relation to Micro-Organisms," by Professor Frankland, F.R.S., a plant being defined as an organism performing synthetical functions, or one in which these functions are greatly predominant; an animal, as an organism performing analytical functions, or one in which these functions greatly predominate. The micro-organisms were classed by the lecturer among animals. Their life essentially depends upon the taking asunder of more or less complex compounds, resolving them into simpler compounds at the expense of potential energy. As micro-organisms are commonly termed "ferments," and their analytical operations "fermentations," it is necessary to sharply distinguish between organized ferments and certain bodies which bring about analogous chemical changes, but which are not only not organized, but exist in solution. These latter, or "soluble ferments," as they are commonly termed, are said to act by contact; they produce certain chemical changes in the fermentescible substances without themselves furnishing from their own substance any of the products of change; the effects they produce are essentially analytical, consisting in the assimilation of water and the splitting up of the fermentescible substance into two or more new molecules, and may be brought about by purely chemical means. They differ only, or chiefly, from the organized ferments in that they are unorganized, and do not increase in amount during their action upon fermentescible substances, of which a very large, although limited, quantity may undergo transformation by the action of a very minute quantity of the ferment. A list of changes brought about by unorganized ferments was given. In that portion of the animal kingdom with which we are best acquainted, oxidation is the essential condition of life; it is the kind of action by which the animal changes actual into potential energy. The changes effected by micro-organisms are essentially of the same character as those brought about by the higher orders of animals; that is to say, they are all changes by which potential becomes actual energy. With one or two exceptions, the chemical changes effected by micro-organisms—unlike those produced by soluble ferments—cannot be brought about by other means. The observations of Hatton and others have shown that micro-organisms retain their vitality in presence of a variety of substances which rapidly prove fatal to higher animals; the unexpected fatal effects of pongy iron would seem to promise, however, that there are substances fatal to bacterial life which have no toxic effect on more highly organized animals. It has not yet been shown that any degree of cold, however intense, is fatal; animation may be suspended, but it is restored when the temperature rises. With regard to heat, the lowest fatal temperature recorded is 40 degrees C., but many species can withstand much higher temperatures. Chloroform and compressed air are said to arrest their action, but have no influence in preventing the changes brought about by unorganized ferments. The position of micro-organisms in nature is only just beginning to be appreciated; their study, both from chemical and biological points of view, is, however, of the highest importance to the welfare of mankind, and leads the inquirer right into those functions of life which are still shrouded in obscurity. In the course of the lecture the best known micro-organisms and the chemical reactions due to them were passed in brief review. Prof. Frankland also referred to the following results of an experiment made in the month of June, in which fresh urine was allowed to stand for twenty-five days in a clean glass vessel:

	Residue Left on Evaporation and Drying at 70° C.	Organic Carbon.	Nitrogen as Urea and other Organic Matter.	Ammonia.	Microscopical Observations.
Fresh urine	4817·0	943·81	1080·27	142·40	No bacilli.
" " after 1 day	—	940·46	1095·05	136·65	" "
" " " 3 days	—	928·76	1105·70	136·50	" "
" " " 5 "	—	882·66	983·36	288·55	Sparse bacilli.
" " " 7 "	—	739·82	900·80	338·60	
" " " 9 "	—	682·99	784·93	485·12	Numerous bacilli.
" " " 11 "	—	621·02	744·64	534·80	Very numerous bacilli.
" " " 14 "	—	559·22	481·49	870·62	Vast numbers of bacilli.
" " " 16 "	—	530·08	492·04	881·87	Mostly still.
" " " 18 "	—	487·01	355·25	900·78	" "
" " " 21 "	—	466·43	278·22	1105·75	All dead or still.
" " " 23 "	—	454·43	347·45	1017·25	" " "
" " " 25 "	2718·0	409·78	283·90	1070·50	
After allowing for evaporation	3045·5	346·77	213·66	805·63	

The results of these observations and determinations, which were made during the month of June, show conclusively that, previous to the development of *Bacillus ureæ*, the chemical composition of the urine remained practically unchanged; but with the appearance of micro-organisms, a diminution of organic carbon and a transference of nitrogen from the organic to the ammonia column immediately began. As regards rapidity, this change marched *pari passu* with the density of population, and reached its maximum about the 12th day; for during the three days (11th to 14th) nearly 10 per cent. of carbon disappeared, while more than 85 per cent. of the organic nitrogen became ammonia. After the 14th day the rate of change became much slower, and on the eighteenth day the bacilli were mostly either dead or motionless, while on and after the 23d day no more moving bacilli were seen. Altogether, the quantity of carbon converted into carbonic anhydride, after allowing for concentration of the liquid by evaporation, amounted to 597·04 parts per 100,000 of liquid, or 63·3 per cent. of the total quantity; while the quantity of organic nitrogen converted into ammonia was 546·19 parts per 100,000, or 50·6 per cent. of the whole. These proportions show that all the organic nitrogen contained in the urea was not converted into ammonia. It no doubt escaped as free nitrogen, in accordance with Frank Hatton's observation. In the original urine the proportion of organic carbon to organic nitrogen was 1 : 1·15, while, after the action of the bacilli, it was 1 : 0·62.

Prof. Burdon Sanderson said that the main difficulty met with in studying the effects of micro-organisms arose from the fact that it was always difficult and often impossible to distinguish between different organisms. Chemists might naturally turn to biologists for aid in the matter, but biologists must admit the existence of this difficulty. We are fully acquainted with the life history of only one pathogenic organism —*Anthrax bacillus;* of this, thanks to Koch, we know, however, a great deal. The method followed by biologists in studying pathogenic forms was, in the first instance, to prepare a pure cultivation of the organism, and then to obtain the proof that the organism produces its proper effect when transferred to a living animal. The morphological relations of bacteria with plants could not be questioned, but he thought it was really of little consequence for practical purposes whether ferment organisms were regarded as animals or plants; what we want to know is, what are the conditions under which an organism is produced, and its life history. He was in the habit of calling them microphytes, as being a neutral term. Prof. Ray Lankester was astonished at the definite way in which Prof. Frankland had classed the ferment organisms with animals. Naturalists were led to regard them as plants from examining their relations to other organisms. He agreed with Prof. Sanderson that "microphyte" was a good name for them, although not precisely for the same reason, but because it really meant a little plant. He stated that it was held hitherto that a micrococcus induced the ammonic change in urine, and not a bacillus, as figured by the lecturer. For the purpose of chemical investigation, it was essential to have a pure cultivation. It was curious that the nitrifying organism had not been isolated; its presence had only been inferred, and it had never been satisfactorily separated and identified, although inconclusive statements and observations purporting to inform us as to the form of that organism had been published. Dr. Brunton said that it was highly probable that the symptoms occurring in certain diseases were due to poisons formed by the action of organisms, and not directly to the organisms themselves.

This was not improbably the case in cholera. Micro-organisms may even produce substances fatal to themselves, *e. g.*, phenyl compounds. This is also the case with higher organisms, the retention of the urine in man being often attended with fatal results. Although cholera was very probably due to the presence of low organisms, the symptoms were so very like those produced by certain poisons that it was very difficult to diagnose cases of poisoning by arsenic from cholera cases. The cholera poison was probably of an alkaloidal character, and related to the ptomaines. Pepsin converted albuminoids into peptones, but it was important to note that Brieger had observed that sometimes an alkaloid having an action similar to curare was formed during peptic digestion, and an alkaloid having a similar action had been obtained from human urine. These facts rendered it probable that alkaloids might be formed in the intestinal canal and absorbed into the general circulation. Prof. M. Foster said that the question whether the micro-organisms in question were plants or animals was to him a matter of indifference compared to the question, What was the exact nature of the action by which the organism effected the chemical change? He desired to point out that in certain cases, as in the ammonic conversion of urea, the same change, in this case the conversion of urea into ammonium carbonate, was effected, on the one hand, by a micro-organism, a micrococcus or bacillus, and on the other hand by an unorganized ferment. His friend Mr. Sheridan Lea informed him that he had evidence of both these causes of ammonic conversion of urea. Now, was the action in both cases the same? The idea had naturally occurred that the organism produced its effect by producing an organized ferment. But all attempts to prove the production of such a secretion, so to speak, of a ferment had failed. If such a ferment were produced, it was destroyed or disappeared during its action, whereas ordinary unorganized ferments, such as pepsin, etc., were not destroyed at all during their activity, or were destroyed very slowly. On the whole, the probability was that the micro-organism and the unorganized ferment produced the same result in different ways; ought not the *difference* to offer the key for solving the problem?

He further desired to remind the Fellows that actions similar to those of these micro-organisms were continually being carried on by the constituent elements of man and other macro-organisms, and would wish, in illustration, to call their attention to the act of secretion by a secreting cell, such as the pancreatic cell. We had evidence that certain constituents of pancreatic juice existed in the cell, not in the form in which they appear in the juice itself, but in an anterior, more complex condition. Thus trypsin occurs in the pancreatic cell not as trypsin but as trypsinogen. Now, this trypsinogen, and also probably other "mothers" of the constituent of the juice, exists in the protoplasm of the cell as *discrete granules, lodged in the meshes of the protoplasm, separated from the protoplasm by films of fluid.* Yet the protoplasm, stirred by some nervous impulse, is able to produce a change in these granules, so that they are discharged to form the secretion. How does the protoplasm work upon these granules? Does it discharge something into the fluid of its meshes, which something acts upon the granules; or does it work upon the granule through the film of fluid surrounding the granule, by something which is a sort of "action at a distance"? The action, then, in this case, is very comparable to the action of the micro-organisms in question. It is for the chemists to throw light on the exact nature of the changes produced, and, when this is done, we may hope to learn how the change is brought about; but not until this is done.

Mr. Thistelton Dyer said that from the botanist's point of view he was struck with the universality of fermentative changes. Though they were so predominant a feature in the life of the lower plants, this was only an extreme manifestation of what, perhaps, all plants were capable of, if the conditions demanded it. Thus Pasteur, following up an experiment of Berard's, found that a rhubarb leaf in an atmosphere of carbon dioxide yielded, after 48 hours, though apparently unchanged, small quantities of alcohol. The breaking up of molecules of large thermic equivalent into those of less, supplies the energy needed for the continued life of the tissues, and is the *raison d'etre* of the process. But plants also set up fermentative changes external to themselves, as it were incidentally and without any obvious benefit.

The investigation of Beyerinck on the production of gum by plants yielded most remarkable results. It is due to a disease which is highly contagious, and which is caused by a fungus (*Coryneum*). This produces a ferment which changes the cell-walls into gum. But what is most remarkable is that even after the disappearance of the fungus which initiated the changes, the cells of the host plant take on a morbid habit of growth, and themselves continue the production of the ferment and therefore of gum to their own hurt. The problem is here of the most complicated kind. The series is ended by cases such as that of *Withania coagulans* (and many others are now known), where plants throw off, as by-products of their metabolism, ferments as effective as rennet, without deriving any perceptible advantage from their possession. That plants use, in working up their reserve-proteid, proteolytic ferments just as animals do, cannot be doubted. But even these they occasionally, as in the papaw, produce in utter disproportion to their own possible requirements. Mr. Warrington said with regard to the difference between animals and plants, he thought the fact had been somewhat overlooked that plants are able to obtain their nitrogen from such simple compounds as ammonia and nitrates, whereas animals appear to require to have the nitrogen presented to them in an albuminoid form. As to the nature of the nitrifying organism, Muntz and Schlosing claim to have isolated it, and have described it. A friend who had

microscopically examined his purest cultivations at Rothamsted, had been unable to find bacilli, but they appeared to contain a micrococcus. [Prof. Lankester, interposing, remarked that the growth sent to him by Mr. Warrington consisted of bacilli, and nothing else.] In explanation, Mr. Warrington said that in one of his earlier papers he had mentioned that white films appeared on some of his solutions. Prof. Lankester had examined these, but he had since found that the bacilli of which they consisted were incapable of nitrifying ammonia. Latterly he had followed Dr. Klein's method, and had introduced the infecting matter into the sterilized cultivation liquid by means of a capillary pipette, which was pushed through the cotton-wool plug closing the tube or flask; since he had done this, the films referred to had never been formed. Dr. Thudichum agreed that the ammonic change was produced in urea by a micrococcus.

The study of microphytes and of the chemical changes produced by them in the human body and in the bodies of animals was of the greatest importance. He questioned whether their action was always so specific, however, as was commonly supposed. He would also call attention to the fact that one micro-organism will kill another; thus, after plastering wine, in consequence of the removal of the tartrate, the microphyte which produces ropiness is crowded out by alcoholic forms. Dr. Stevenson called attention to the importance of obtaining more information as to the alkaloidal bodies formed by the action of micro-organisms. Prof. Frankland replied that he did not mean absolutely to say that in his experiment the work was done by the *Bacillus ureæ*, but the diagram was a faithful representation of what he saw; he attributed the action to this particular organism, because it commenced when the organism appeared, and ceased, when the bacilli became motionless. The necessity of studying the actions of pathogenic organisms had been prominently brought forward in the discussion. He thought there was a substantial difference between the class of chemical changes effected by plants on the one hand, and by animals on the other; animals more particularly consumed as food those compounds in which much energy was stored up.—*Nature.*

THE TIME ELEMENT IN GLUTEN DETERMINATION.

By WM. FREAR.

FEW writers on food or plant analysis, in describing Beccari's method for the determination of gluten in grain or flour, make note of the influence of the length of time which elapses between the preparation of the dough and the separation of the starch, upon the quantity of gluten obtained. It has, however, long since been observed by some of the chemists who have given particular attention to the analysis of cereals and albuminoids, that better results are obtained if the dough is allowed to stand for some time before washing. Von Bibra * recommends a period of fifteen minutes; Ritthausen † makes it thirty minutes; Peligot ‡ says that from thirty to fifty minutes is best. Still, though these authors mention definite periods, their disagreement and the fact that in no case are there given experimental data leading to the adoption of the limits named, indicate that they have been arbitrarily selected.

The experiments of Weyl and others having pointed to the conclusion that gluten is produced by the action of an unorganized ferment, MM. Benard and Girardin § made some experiments to determine the rapidity and duration of its action. Three equal portions of dough from the same flour were washed, one immediately after preparation, another thirty minutes after, and the third three hours after. The percentages of "moist gluten" obtained from experiments on three samples were as follows:

Immediately.	30 minutes.	3 hours.
24·40	27·40	30·80
26·20	29·20	31·20
22·60	28·20	28·40

The third sample contained more moisture than the others.

From these results the authors conclude that it is best to wait at least *three hours* before washing.

Recently, in the course of a number of gluten determinations, I was led, without any knowledge of the investigations of MM. Benard and Girardin, to experiment upon the same point. A few trials having shown the great increase during the first thirty minutes, the samples of dough were allowed to stand for longer periods, in order to fix the point at which the formation of gluten was practically complete. In preparing the dough, 20 grammes of the sample were mixed with 10–15 c. c. of water. The results, stated in the percentages of "dry gluten" obtained, were as follows:

H. min.	Per cent.	H. min.	Per cent.	Difference.
0 45	10·94	2 35	10·76	—0·18
0 55	11·81	2 35	11·58	—0·23
1 00	10·77	3 00	10·75	—0·02
1 00	11·01	2 00	11·00	—0·01
1 15	11·22	3 40	11·11	—0·01
2 15	12·41	3 00	12·77	+0·36
1 30	10·55	2 30	9·95	—0·60

The last column is surprising because, instead of showing an increase during the longer interval, it seems to indicate an almost invariable decrease. This, however, is explained by the fact that on standing the dough is covered by a pellicle which gradually becomes harder and thicker; and on washing, instead of becoming homogeneous, breaks into small pieces, which will, unless great care be exercised, wash out with the starch, carrying incorporated with them a very considerable portion of the gluten. Thus, No. 7 being an unbolted flour, the loss was much greater because bran renders the pellicle more difficult to soften. In No. 6, the difference in time being small, the increase is more probably due to an accidentally greater loss in the first of the duplicates.

These results, then, indicate that the formation of gluten is practically complete in from forty-five minutes to an hour after the dough is prepared; and that the adoption of a longer period, by increasing the difficulty of the following parts of the process, introduces a source of error rather than a condition favorable to the fairest results.—*Amer. Chem. Jour.*

* "Die Getreidearten und das Brod," 1861, p. 140.

† "Die Eiweisskorper der Getreidearten, Hulsenfruchte und Oelsamen," 1872, p. 3.

‡ "Traite de Chimie Analytique appliques a l'Agriculture," Paris, 1888. p. 371.

§ *J. Phar. et Chim.* (5) 4, 1881, pp. 127, 128.

BENJAMIN WARD RICHARDSON, M.A., LL.D., F.R.S.

BENJAMIN WARD RICHARDSON was born at Somerby, in Leicestershire, on the 31st October, 1828. He received his early education at the school of the Rev. W. T. Nutt, at Burrow-on-the-Hill in the same county, afterward proceeding to the Andersonian University at Glasgow, and graduating at St. Andrews in 1854. In the same year he gained the Fothergilian medal for an essay on the diseases of the child before birth, and the Astley Cooper prize of £300 for an essay on the coagulation of the blood. In 1855 he orginated the *Journal of Health*, later the *Social Science Review*, which he conducted for several years. He became in 1856 a member by examination of the Royal College of Physicians.

In 1865 he commenced a series of experiments in practical physiology, in order to ascertain the nature of the poisons in contagious diseases, which resulted in the detection of a special poisonous product common to them all, which he named *septine*. In the following year he introduced the use of ether spray to alleviate the local pain in surgical operations. Later, he also introduced the use of methylene bichloride in similar cases.

In 1873 he announced the result of experiments which added greatly to our knowledge of the phenomenon of muscular irritability. The subjects brought under consideration were (1) the effect of cold on muscular irritability after systemic death; (2) the effect of motor forces; (3) the effect of abstracting or supplying blood; and (4) the effect of certain chemical agents, organic or inorganic. The researches were fully detailed in the

BENJAMIN WARD RICHARDSON.

Croonian Lecture delivered by Dr. Richardson in 1873. In 1875, at the Social Science Congress held at Brighton, Dr. Richardson delivered an address, afterward published, entitled "Hygeia; a City of Health," giving a description of a city perfect in all its sanitary arrangements. The book attracted great attention, and an attempt was made to promote a model city on this basis. A site was secured near Worthing, but the enormous expense of the scheme led to its early abandonment.

During the agitation against vivisection, Dr Richardson rendered great service to the cause of the experimental physiologist by his evidence, showing the many valuable discoveries leading to the prevention or alleviation of disease which could not have been accomplished without the aid of experimentation on animals. Among other important discoveries, he claimed as the result of vivisection or similar processes the deposition of fibrine in the heart, and the means by which it may be checked; the properties of ether spray and various anæsthetics; various means of restoring suspended animation; the operation of tracheotomy in diphtheria; the influence of nitrite of amyl on the nervous system; and the operations for cataract.

Besides being a skillful physiologist and a great sanitary reformer, Dr. Richardson is well known as a leader among men of science in the great temperance movement, in the interests of which he has written several essays and pamphlets. He is a Fellow of the Royal Society, and has been President of the Medical Society of London and four times President of the St. Andrews Medical Graduates' Association. He is also Assessor for the General Council in the University Court of St. Andrews, and Honorary Physician to the Royal Literary Fund.—*Science Monthly.*

THE MENTAL STATES INDUCED BY FRIGHT.

THE *Wiener Medizinische Wochenschrift*, of July 19, 1884, contains an abstract of an interesting account of the earthquake at Ischia, written by Dr. Fazio, an eyewitness of the scene. The emotions awakened by the catastrophe were of the most varied character. During the fifteen seconds that the shock continued everybody stood still, seemingly rooted to the ground with terror. Men were weak in the knees and shook as with ague, feeling as though they were about to fall, but none of them had convulsions, delirium, or syncope. But soon this stillness was broken by loud cries and howls, and every one rushed toward the shore. Then women and children fell into convulsions or appeared to be semi-paralyzed and speechless. Rudeness and brutality were mingled with self-sacrifice and heroism of the most exalted character. Six hours after the catastrophe the stillness of death reigned over Casamicciola. Men wandered about the ruins half clad and silent, as if risen from the grave; women were excited and hysterical; children of eight or ten years seemed dazed and stupefied, while smaller children stood around, unconcernedly eating whatever they could find in the ruins. It is most interesting to see the different ways in which individuals were affected by the shock. The keeper of a refreshment booth, who had lost everything, kept offering his delicacies to those who passed by, just as though everything had not been swept away. A surgeon, covered with blood and sorely wounded by the fallen beams, was concerned only for his instruments, and inquired after them of everybody whom he encountered. A hysterical woman, who had been bed-ridden for months, jumped up and saved herself by flight, and remained permanently cured. Many who were at first brave and full of energy became later depressed and apathetic, or had convulsions or alternate fits of laughter and crying. Sometimes a melancholia was induced which continued for months, and many became incurably insane. Abortion was very common, and there were many cases of suddenly arrested menstruation. The sexual appetite was universally destroyed for many days after the earthquake, and in many instances there was also an aversion to food. There was numerous cases of retention of urine, sometimes lasting for days and demanding catheterization. There were several instances in which the hair was whitened by fright, and even some boys of ten to fourteen years showed heads sprinkled with gray. Many of those buried in the ruins exhibited the greatest indifference to their fate, following listlessly with their eyes the motions of those busied in their rescue. A foreign officer, whose legs were imprisoned under some heavy timbers, drew out a cigarette and smoked it with the utmost nonchalance. One man, as soon as he was pulled from the ruins, shook his rescuer by the hand, and presented him with his card. Another, who lay beneath the debris for twenty hours, immediately looked at his watch in order to record the exact instant of his deliverance. A lady who had been just extricated from a mass of rubbish would not budge from the spot until she could ascertain the fate of her pet dog, which was buried with her. One woman, who heard a man calling for his daughter, deceived him so cunningly that she was rescued by him before the trick was discovered. Most of the people, however, who were imprisoned beneath the ruins were too indifferent to their fate to attempt any such deception, and most of them had not the slightest idea of the length of time during which they were buried. Most of those who were wounded by the falling buildings underwent the necessary surgical operations without experiencing any pain, though some were hyperæsthetic.—*Medical Record.*

GALVANIZED IRON WATER PIPES.

By F. P. VENABLE, Ph.D.

THE increase in the use of galvanized iron, especially in the form of water tanks and pipes, has led to a reopening of the question as to the possible injurious effects from the use of such water. It is a matter of importance, then, to us how far our knowledge extends on this subject, and I will collect here all of the known facts so far as I have been able to get at them.

The so-called galvanized iron is of course nothing more than iron dipped in a bath of zinc, and so superficially coated with it and to a certain extent alloyed with it. The character of the protection afforded the iron is galvanic (hence the name), the two metals forming a galvanic couple, so that under the action of any

exciting liquid the zinc and not the iron is attacked. That zinc dissolves in potable waters has long since been shown by the experiments at Boutigny, Schaueffele, and Langonne. Distilled water and rain water dissolve it more readily than hard water. Especially is water containing carbonic acid capable of this solvent action. So much may be taken up that the water becomes opalescent and acquires a distinctly metallic taste. It seems that by the action of water, hydrate and carbonate of zinc are gradually formed, and that this action is more rapid in the presence of certain saline matters, but is weakened by the presence of calcium salts.

As to the injurious effects of such waters, authorities differ. Fonssagrives has investigated the question, consulting the statistics of the French Navy and the recorded experiments of others, adding, however, none of his own. The French Government had, before this, appointed a committee to make a special report on the subject, and the investigations of Roux in 1865 and 1866 furnished evidence enough of possible injury to health from water stored in galvanized iron tanks to lead to an order from the Minister of Marine, prohibiting the use of such tanks on board of ships of war. Boutigny attributed grave effects to the use of these zinc-containing waters, looking upon it as probably resulting in epilepsy. Fonssagrives, however, maintains that the zinc is not cumulative, and produces no bad effects unless taken in large doses. Doubt is thrown on this position, however, by the fact that his assertions as to the limited solubility of zinc in ordinary drinking water are not sustained by experiments. Without doubt such waters have been used for considerable lengths of time and no injurious effects have been noticed. This may have been due, however, to the hardness of the water, and hence the small amount of zinc dissolved. Pappenheim states in contradiction to the assertion of Fonssagrives that zinc vessels are dangerous, and must be carefully avoided. Dr. Osborne, of Bitterne, has frequently observed injurious effects from the use of waters impregnated with zinc. Dr. Stevenson has noticed the solvent action of rainwater on galvanized-iron, and states that probably its continued use would cause injury to health. He recommends as a convenient test for the presence of zinc in potable waters, the addition of potassium ferrocyanide to the filtered and acidulated water. Zinc gives a faint white cloud or a heavier precipitate when more is present. Dr. Frankland mentions a case of zinc poisoning where well-water, containing much dissolved oxygen and but little carbonic acid, was used after passing through galvanized iron pipes. Professor Heaton has recorded the analysis of a spring water in Wales, and a second analysis of the same water after passing through half a mile of galvanized iron pipe, showing that the water had taken up 6·41 grains of zinc carbonate per gallon.

A similar instance of zinc-impregnated water has come under my own observation, and I append the analytical results. The water from a spring 200 yards distant was brought by galvanized iron pipes to a dwelling house and there stored in a zinc-lined tank, which was painted with white lead. The water became somewhat turbid and metallic tasting, and its use for drinking purposes was discontinued. Analyses were made after the pipes had been in use about one year. A somewhat full analysis of the spring-water was made under my direction by Mr. J. C. Roberts. The analyses of water from the tank and directly from the pipe I carried out only as far as zinc, iron, and tests for lead were concerned. The results are calculated in grains per gallon of 231 cubic inches.

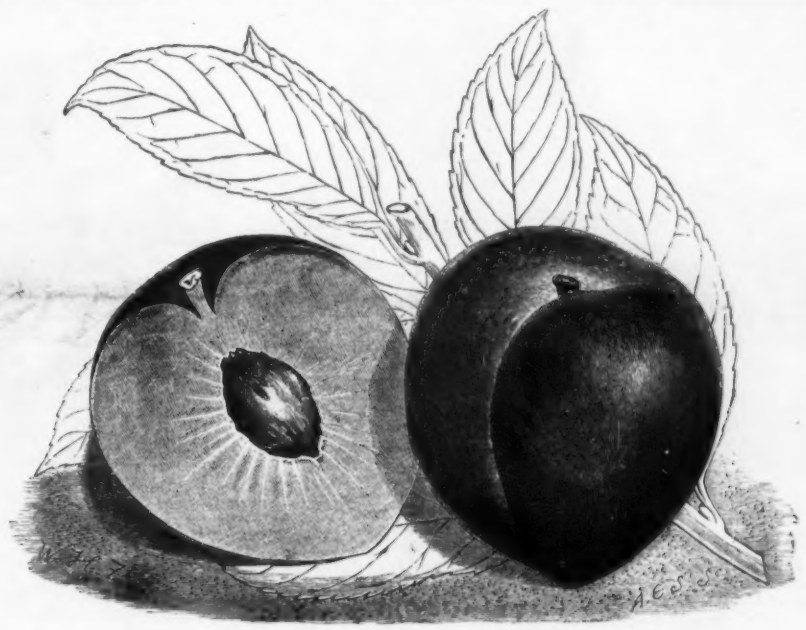
Analysis of Spring.

	Grains.
Silica	2·45
Lime	0·23
Magnesia	0·17
Alkalies	0·43
Chlorine	0·35
Sulphuric acid	0·19
Carbon dioxide (calculated)	0·45
Total residue on evaporation	4·34

It is evident, then, when the dangerous nature of zinc as a poison is taken into consideration, that the use of zinc-coated vessels in connection with water or any food-liquid should be avoided.—*Journal of the American Chemical Society.*

THE FORMS OF LEAVES.

SIR JOHN LUBBOCK, M.P., recently delivered a lecture on the above subject at the Royal Institution. The lecturer said that, greatly as we all appreciated the exquisite loveliness of flowers, it must be admitted that the beauty of our woods and fields was even more due to the marvelous grace and infinite variety of foliage. How, he asked, was this inexhaustible richness of form to be accounted for? Did it result from an innate tendency of the leaves in each species to assume some particular shape? Had it been intentionally designed to delight the eyes of man, or had it reference to the structure and organization, the wants and requirements of the plant itself? If we considered, first, the size of the leaf, we should find that it was regulated mainly with regard to the thickness of the stem, and that, when strict proportion was departed from, the difference could generally be accounted for. This was shown by a table giving the leaf-area and the diameter of stem of the hornbeam, beech, elm, lime, Spanish chestnut, ash, walnut, and horse chestnut. The size, once determined, exercised much influence on the form. For instance, in the beech the leaf had an area of about three square inches. The distance between the buds was about one and a quarter inches, and the leaves lay in the general plane of the branch, which bent slightly at each internode. The basal half of the leaf fitted the swell of the twig, while the upper half followed the edge of the leaf above, and the form of the inner edge, being thus determined, decided that of the outer one also. In the lime the internodes were longer and the leaf consequently broader. In the Spanish chestnut the stem was nearly three times as stout as that of the beech, and consequently could carry a larger leaf surface. But the distances between the buds were often little greater than those in the beech. This determined the width, and, by compelling the leaf to lengthen itself, led to the peculiar form which it assumed. Moreover, not only did the leaves on a single twig admirably fit one another, but they were also adapted to the ramification of the twigs, and thus availed themselves of the light and air, as we could see by the shade they cast, without large interspaces or much overlapping. In the sycamores, maples, and horse chestnuts the arrangement was altogether different. The shoots were stiff and upright, with leaves placed at right angles to the plane of the branch, instead of being parallel to it. The leaves were in pairs and decussate with one another, while the lower ones had long petioles, which brought them almost to the level of the upper pairs, the whole thus forming a beautiful dome. For leaves arranged as in the beech, the gentle swell at the base was admirably suited, but in a crown of leaves, such as those of the sycamore, space would be thereby wasted, and it was better that they should expand at once, as soon as their stalks had carried them free from the upper and inner leaves. Hence we saw how beautifully the whole form of these leaves was adapted to the mode of growth and arrangement of the buds in the plants themselves. In the black poplar the arrangement of the leaves was again quite different. The leaf stalk was flattened, so that the leaves hung vertically. It would be observed that, while in most leaves the upper and under surfaces were quite unlike, in the black poplar, on the contrary, they were very similar. The stomata, or breathing-holes, moreover, which in the leaves of most trees were confined to the under surface, were in this species nearly equally numerous on both. The compass plant of the American prairies, a yellow composite, not unlike a small sunflower, was another plant with upright leaves, which growing in the wide open prairies tended to point north and south, thus exposing both surfaces equally to the light and heat. It was shown by diagrams that this position also affected the internal structure of the leaf. In the yew the leaves were inserted close to one another, and were long and linear, while in the box they were further apart and broader. In the Scotch fir the leaves were linear and 1¼ in. long; while in other pines, the Weymouth, for instance, the stem was thicker and the leaves longer. In the plants hitherto mentioned, one main consideration appeared to be the securing of as much light as possible; but in tropical countries the sun was often too powerful, and the leaves, far from courting, avoided the light. The typical acacias had pinnate leaves, but in most Australian species the true leaves were replaced by a vertically flattened leafstalk. It would be found, however, that the seedlings had leaves of the form typical in the genus. Gradually, however, the leaf became smaller and smaller, until nothing was left but the flattened leafstalk or phyllode. In one species the plant throughout life produced both leaves and phyllodes, which gave it a very curious and interesting appearance. In eucalyptus, again, the young plant had horizontal leaves, which in older ones were replaced by scimetar-shaped phyllodes. Hence the different appearance of the young and old trees which must have struck every visitor to Algiers or the Riviera. So much for deciduous trees. In evergreens the conditions were in many respects different. It was generally said that leaves dropped off in the autumn because they died. This, however, was not strictly correct. The fall of the leaf was a vital process, connected with a change in the cellular tissue at the base of the leafstalk. If the leaves were killed too soon, they did not drop off. The lecturer illustrated this by some twigs which he had purposely broken in the summer; below the fracture the leaves had been broken off, above they still adhered, and so tightly that they could support a considerable weight. In evergreen trees the conditions were in many respects different. It was generally supposed that the leaves lasted one complete year. Many of them, however, attained a much greater age; in the Scotch fir, three or four years; in the spruce, or silver, six or seven; in the yew, even longer. It followed from this that they required a tougher and more leathery texture. When we had an early fall of snow, our deciduous trees were often much broken down; glossy leaves had a tendency to throw it off, and thus escape; hence evergreen leaves were very generally smooth and glossy. Again, evergreen leaves often had special protection, either in an astringent or aromatic taste, which rendered them more or less inedible, or by thorns and spines. Of this the holly was a familiar illustration, and it was pointed out that in old plants, above the range of browsing quadrupeds, the leaves tended to lose their spines, and become unarmed. The hairs on the leaves were another protection. On herbs the presence of hairs was often associated with that of honey, as they protected the plants from the visits of creeping insects. Hence, perhaps, the tendency of water species to become glabrous. Polygonum amphibium being a very interesting case, since it was hairy when growing on land, and smooth when in water. The lecturer then dealt with cases in which one species might be said to mimic another, and he exhibited a striking photograph of a group of stinging nettles and dead nettles, which were so much alike as to be hardly distinguishable. No one could doubt that the stinging nettle was protected by its poisonous hairs, and it was equally clear that the innocuous dead nettle must profit by its similarity to its dangerous neighbor. Other similar cases were cited. Reference was next made to aquatic plants, many of which had two kinds of leaves, one more or less rounded, which floated on the surface, and others cut up into narrow filaments, which remained below. The latter thus presented a greater extent of surface. In air, however, such leaves would be unable to support even their own weight, much less to resist any force, such as that of the wind. But in perfectly still air, for the same reason, finely divided leaves might be an advantage, while in comparatively exposed situations more compact leaves might be more suitable. It was pointed out that finely-cut leaves were common among low herbs, and that some families, which among the low and herb-like species had such leaves, in shrubbery or ligneous ones had leaves more or less like those of the laurel or beech. An interesting part of the subject was connected with the light thrown by the leaves of seedlings. Thus the furze had at first trifoliate leaves, which gradually passed into spines. This showed that the furze was descended from ancestors which had tripartite leaves, as so many of its congeners had now. Similarly, in some species, which, when mature, had palmate leaves, those of the seedling were heart-shaped. Perhaps, in all cases, the palmate form was derived from the heart-shaped, and when in any genus we found heart-shaped and lobed leaves, the former might represent the earlier or ancestral condition. If there was some definite form told off for each species, then surely a similar rule ought to hold good for each genus. The species of a genus might well differ more from one another than the varieties of any particular species; the generic type might be, so to say, less closely limited; but still there ought to be some type characteristic of the genus. One genus was that of senecio (the groundsel). In addition to senecios more or less resembling the common groundsel, there were species with leaves like the daisy, bushy species with leaves like the privet and the box, small trees with leaves like the laurel and the poplar, climbing species like the tamus and bryony. In fact, the list was a very long one, and showed that there was no definite type of leaf, but that the form in the various species depended on the condition of the species. From these and other considerations, the lecturer concluded that the forms of leaves did not depend on any inherent tendency, but to the structure and organization, the habits and requirements of the plant. Of course, it might be that the present form had reference to former, and not to present conditions. This rendered the problem all the more complex and difficult. The subject presented a very wide and interesting field of study, for if he were correct in his contention, every one of the almost infinite forms of leaves must have some cause and explanation.



NEW JAPAN PLUM.

NEW JAPAN PLUM.

THE plum of which we give an illustration, from the pencil of Mr. Fitch, was exhibited before the Fruit Committee on October 14 last, by Mr. Bull. The fruits attracted much attention, being much more like nectarines in color than plums, though, it is true, more elongated in form. The flesh is firm, yellow, and of good flavor, and as Mr. Bull received the fruit direct from California, whence it arrived in good condition, nothing further need be said as to its qualifiations as a traveler. The tree was introduced from Japan to California in 1871. According to the *Pacific Rural Press*, the tree is very prolific, and Messrs. Hammon & Co., of Oakland, who have propagated it, claim for it these merits:

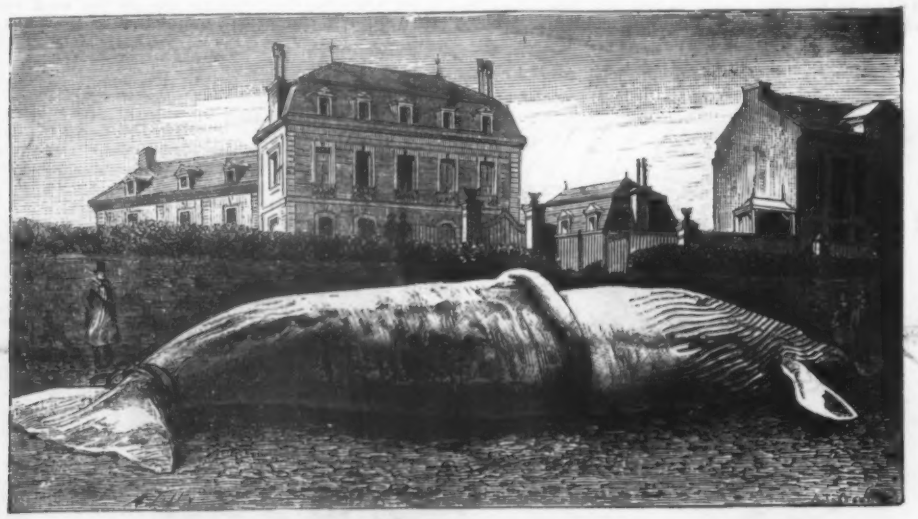
"1. Its wonderful productiveness is unsurpassed by any other plum, either native or foreign. 2. It

comes into bearing at the age of two to three years, and continues with great regularity, blossoms frequently appearing on yearling trees. 3. The fruit is of very large size, being from 7 to 9 inches in circumference, and specimens weighing 6½ oz. each, and it has a remarkably small pit. 4. It is very attractive in appearance, being of a rich yellow nearly overspread with a bright red, with a lovely bloom. It is heart-shaped. It ripens from first to last of September, at a most favorable time for harvesting and marketing the crop, the larger part of the plum crop being gone. 5. It is of superb quality, melting, rich, and juicy; in fact, to some tastes, at least, has a more satisfying flavor than any other plum. For cooking, jelly, or preserving in any manner it has no equal. Its large size renders the paring of the frust as practicable as in the peach, which is quite a novelty in the line, and excels all other canning plums. As a dried fruit it is destined to take the lead, equal to if not surpassing the best dried prunes or peaches for drying results."—*The Gardeners' Chronicle.*

A STRANDED WHALE.

IT is not usual to meet with a whale on the seashores of Normandy, and so it may be conceived that such an event produced much excitement in the locality where it occurred. We have already informed our readers that toward the middle of January a whale came ashore at Luc-sur-Mer, on the coast of Calvados, in front of the very windows of the Laboratory of Marine Zoology. Prof. Delage of the Caen Faculty of Sciences informs us that the animal was a very well preserved male specimen of *Balenoptera musculus*. The animal appeared to have been dead for about three weeks. Its total length was about sixty feet.

The photograph which we reproduce in the accompanying cut represents the whale lying upon its back. The head is partly buried in the sand, and the animal's immense tongue protrudes from its mouth. One of the jaws has recently been removed with the intention of preserving it, and casts have been taken



A STRANDED WHALE.

of certain interesting parts. The entire skeleton and skin are to be mounted for the Museum of the School of Medicine of Caen.—*La Nature.*

EARTHQUAKES.

THE *Transactions* of the Seismological Society of Japan for 1885 (vol. vii., part 2) contains a paper, by Prof. Milne, on 387 earthquakes observed during two years in North Japan. To determine the extent of country over which an earthquake was felt, he distributed bundles of post-cards to the Government officials at all important towns within a distance of 100 miles of Tokio, with a request that every week one of the cards should be posted with a note of any earthquakes that might have occurred. By this expedient it was discovered that the Hakme Mountains to the south of the Tokio plain appeared to stop every shock coming from the north, and accordingly the barrier of post-cards was stopped in that direction, but was extended gradually to the north until it included the forty-five principal towns in the main island to the north of Tokio, besides several places in Yezo. In Tokio, observations as to direction, velocity, and intensity were made with various earthquake instruments.

A description of the principal instruments used, with a comparison of their relative merits, has already been given by Prof. Milne in vol. iv. of the *Transactions* of the Society. The second part of the paper is devoted to a list of the 387 earthquakes recorded, with particulars of each; 124 maps of earthquake districts, as well as numerous other illustrations, are appended.

The results of an exhaustive study of these earthquakes may be summed up as follows: (1) As to distribution in space: of the 387 shocks, 254 were local, that is, they were not felt over an area greater than 50 square miles; 198 of these were confined to the seaboard, and 56 were inland. The average diameter of the land surface over which the remaining 133 extended was about 45 miles, but four or five of them embraced a land area of about 44,000 square miles. These great shocks originated far out at sea, and consequently were not so alarming in their character as many which originated nearer to or beneath the land. (2) Simultaneous shocks: some of the disturbances took place at areas remote from each other, while intermediate stations did not record them. (3) Origins of earthquakes: the general result under this head is that the greater number of earthquakes felt in northern Japan originated beneath the ocean; 84 per cent. of the whole having so originated. The district which is most shaken is the flat alluvial plain around Tokio. Indeed, the large number of earthquakes felt in low ground as compared with the small number felt in the mountains is very remarkable. It is also noticeable that in the immediate vicinity of active or recent volcanoes seismic activity has been small. The map marking the general distribution of volcanoes and the regions of the greatest seismic activity shows that these are not directly related to each other. The district, too, where earthquakes are the most numerous is one of recent and rapid elevation, and it slopes down steeply beneath an ocean which, at 120 miles from the coast, has a depth of about 2,000 fathoms, while on the other side of the country, where earthquakes are comparatively rare, at the same distance from the shore the depth is only about 120 fathoms. In these respects the seismic regions of Japan resemble those of South America, where the earthquakes also originate beneath a deep ocean, at the foot of a steep slope, on the upper parts of which there are numerous volcanic vents, while on the side of this ridge opposite to the ocean earthquakes are rare. (4) Relation of earthquakes to various natural phenomena: the preponderance of shocks in winter, as revealed by this investigation, is really remarkable; 278 took place in the winter months, as against 109 in the summer, and of the former number, 195, or more than half of the whole number for the two years, took place in the three coldest months of the year, viz., January, February, and March, in other words, there is a general coincidence between the maximum of earthquakes and the minimum of temperatures. But the relation of the seismic *intensity* (as distinct from the number of earthquakes) is even more remarkable, for the figures show that the winter intensity is nearly three and a half times as great as the summer intensity. M. Perrey thought he discovered a maximum of earthquakes for the moon's perigee, but no such maximum has been found for Japan. Speaking generally, no marked coincidence was found in the present instance in the occurrence of earthquakes and the phases of the moon. The above are the general results, stated briefly, of the most exhaustive and remarkable study yet undertaken in the domain of seismology.

La Nature contains a long report on the Andalusian earthquakes, from the pen of M. Nogues, a mining engineer of Granada, which, as being the first scientific investigation of the catastrophe, is worthy of special notice. The whole movement presented three phases. The first manifested itself prior to December 25, at Pontevedra, Vigo, and in Portugal; in other words, in the eastern part of the Iberian peninsula. The second was very short and intense, and made itself felt in the center and south; it reached its maximum intensity on the night of December 25. The third phase lasts still in the provinces of Granada and Malaga, and extended east to Valencia. The oscillatory movement of December 25 embraced a considerable superficial extent. The disturbed area in the peninsula is comprised between Cadiz and Cape Gaeta, between Malaga and the Carpetena chain. The movement became more and more intense as it left this mountainous mass and traveled in a southerly direction, until it attained its maximum in the region between the Serrania de Ronda and the Sierra Nevada of Granada. The oscillatory motion was gradually accentuated toward the south, especially on the southern side of the great central Spanish plateau, bounded by the slope of the valley of the Guadalquivir (Seville, Cordova, Malaga, and Granada). M. Garcia Alvarez localizes the phenomenon in Andalusia, and regards the Sierra Nevada as the point of departure. M. Nogues then deals in succession with the relations between the seismic motions and the geological structure of the district, the geological phenomena, such as fissures in the earth, produced by the earthquakes, and alterations caused by them in the level of springs. He sums up his conclusions by pointing out that the geological observations which have been made so far, although local, limited, and imperfect, demonstrate that there were two different kinds of motions—one oscillatory, the other a trembling movement. Every one who felt the great earthquake of the 25th experienced first a vertical shock, and then, after a short interval, another movement like a balancing. A great fissure at the village of Guevejar presents at two points two interesting sections. At one the trunk of an olive tree has been split in two from its root to the branches, as if from a blow of a hatchet, each part occupying a side of the fissure, one on one side, the other on the other. At another part the fissure has divided in two the wall supporting the wheel of the powder factory at Guevejar. The cracks in the houses in the village are in lines parallel to these fissures, and the marks left in the soil indicate an oscillatory motion. The chimneys, in many cases, were turned half around on their axes, without any further disturbance of a single portion of the structure; and, in fact, an examination of the various marks left by the earthquake of December 25 places it beyond doubt that there was a trembling as well as an oscillatory movement.—*Nature.*

FINGAL'S CAVE.

M. DAUBREE presented to the French Academy at its session of December 1st the treatises of Mr. Cope Whitehouse on the caves of Staffa. The highest French authority on this subject has thus expressed approval of the cogency of the arguments by which the American *savant* has shown that the popular opinion of the formation of Fingal's Cave by the sea is untenable, and that it must be referred to the agency of man, and probably of that race which has left its traces in other great works in stone on the Irish and Scotch coasts.

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TABLE OF CONTENTS.

PAGE

I. CHEMISTRY.—A Great Magnesia Mine.—Treating of the production of magnesia from sea water at Aigues-Mortes..... 7755
Cyanide of Potassium..... 7756
The Production of Ammonia from the Nitrogen of Minerals.—A paper read before the Society of Arts by M. GEORGE BEILBY.—5 figures..... 7757
Chemical Changes in their Relation to Micro-Organisms.—Abstracts of a lecture by Professor FRANKLAND..... 7763
The Time Element in Gluten Determination.—By WM. FREAR... 7764

II. ENGINEERING AND MECHANICS.—Accident to the Gas Holders of the St. Louis Gas Company..... 7761
Sight Feed Lubricator.—With engraving..... 7761
Lead Case Press.—2 figures..... 7761

III. TECHNOLOGY.—Improved Potash Developer for Collodion Emulsion Plates for Transparencies, etc..... 7756
How to Make Gelatino-Chloride Paper for Printing without Developing..... 7756
The Rolling Planimeter.—By F. H. REITZ.—With engraving..... 7756
The Perfumer's Manual.—By an experienced manufacturer.—Treating of the manipulation of pomades, etc., and giving numerous recipes for extracts..... 7759

IV. ARCHITECTURE AND ART.—The New Votive Church at St. Petersburg.—With engraving..... 7751
The Influence of Wood upon Architecture..... 7751
The Shoring of Buildings.—By THOS. BLASHILL.—Use of shoring.—Causes of mischief to buildings.—Foundations.—Different kinds of shoring.—2 figures..... 7752
New Offices and Business Premises, Sheffield.—An engraving..... 7754
The Dying Achilles.—A marble statue by Ernst Herter.—An engraving..... 7754

V. PHYSICS, ELECTRICITY, ETC.—Guichard's Thermometer.—2 figures..... 7761
New System of Telegraph and Telephone Conductors.—3 figures.. 7762
Synchronism.—By Prof. E. J. HOUSTON.—A paper read before the Institute of Electrical Engineers.—With illustrations..... 7762

VI. BOTANY, ETC.—The Forms of Leaves.—Abstract of a lecture by Sir JOHN LUBBOCK..... 7765
New Japan Plum..... 7765

VII. HYGIENE, ETC.—The Mental States Induced by Fright..... 7764
Galvanized Iron Water Pipes.—Is water conducted through the same injurious?—By F. P. VENABLE..... 7765

VIII. MISCELLANEOUS.—A Stranded Whale.—With engraving..... 7766
Earthquakes.—Study of the same in Japan and in Spain..... 7766

IX. BIOGRAPHY.—Benjamin Ward Richardson, M.A., LL.D., F.R.S.—With portrait..... 7764

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